State of California
The Resources Agency

Department of
Water Resources

save water
DWR

The California State Water Project

Appendix E
Water Operations in the Sacramento-San Joaquin Delta During 1976

Bulletin 132-77
October 1978

ON THE COVER: Sutter Slough Closure, a rock barrier constructed by DWR to increase flows in the Sacramento River and other channels east of Sutter Slough. The closure made it possible to divert water—that otherwise would have traveled down Sutter Slough and wasted to the ocean—to the central Delta waterways. This temporary closure helped meet water quality criteria in the Delta and also helped conserve the dwindling water resources of the State Water Project.

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Water Resources

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Huey D. Johnson
Secretary for Resources

The Resources Agency

Edmund G. Brown Jr.
Governor

State of California

Ronald B. Robie
Director

Department of Water Resources

FOREWORD

The Sacramento-San Joaquin Delta has often been called the focal point of water resources development in California's Central Valley. The Delta is the collection point for water delivered to State Water Project customers in the San Francisco Bay area, the San Joaquin Valley, and Southern California.

In transferring water through the Delta, the Project significantly affects flows in the Delta's network of interconnected rivers and sloughs. These redistributions of flow also affect Delta water quality. The project is therefore operated to protect the multiple beneficial uses within the Delta, and the adjoining Suisun Bay region, in terms of both flow and water quality, while still performing its water-delivery functions.

Appendix E to Bulletin 132-77 is one of an annual series of reports describing State Water Project activities in the Delta. In addition to presenting the details of the Project's complex Delta water operations, Appendix E reviews Delta water quality, especially in terms of objectives established by the State Water Resources Control Board. The Project's comprehensive Delta monitoring program is discussed, as are the results of Delta environmental studies in which the Project participates. The Appendix E series is thus designed to document significant Delta events as well as to review the Project's overall Delta operations programs. In focusing on SWP operations, Appendix E does not consider other Central Valley water resources development in detail.

1976 was the first year of operation in the most severe drought in the State's history, and the first dry period since project operations began. As a result it was a time of trial and error, and learning. Unfortunately, SWP operations were complicated by the failure of the Federal CVP to operate to meet State Water Resources Control Board water quality standards in the Delta. Since the SWP was operated to these standards, we dedicated 91,408 acre-feet of SWP supply to make up for this federal operation.

This Appendix has been published prior to Appendix E to Bulletin 132-76 in order to place priority on the presentation of information regarding SWP operations during the challenging first year of the drought. Appendix E to Bulletin 132-76, to be published early in 1979, will summarize the Project's Delta activities from the initiation of the SWP through 1975.

Ronald B. Robie, Director
Department of Water Resources
The Resources Agency
State of California

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The California Water Commission serves as a policy advisory body to the Director of Water Resources on all California water resource matters. The nine-member citizen Commission provides a water resources forum for the people of the State, acts as liaison between the legislative and executive branches of State Government, and coordinates Federal, State, and local water resources efforts.

2—78947

CONVERSION FACTORS

English to Metric System of Measurement

Quantity	English unit	Multiply by	To get metric equivalent
Length	inches (in)	25.4	millimetres (mm)
		.0254	metres (m)
	feet (ft)	.3048	metres (m)
	miles (mi)	1.6093	kilometres (km)
Area	square inches (in^2)	6.4516×10^{-4}	square metres (m^2)
	square feet (ft^2)	.092903	square metres (m^2)
	acres	4046.9	square metres (m^2)
		.40469	hectares (ha)
		.40469	square hectometres (hm^2)
		.0040469	square kilometres (km^2)
	square miles (mi^2)	2.590	square kilometres (km^2)
Volume	gallons (gal)	3.7854	litres (l)
		.0037854	cubic metres (m^3)
	million gallons (10^6 gal)	3785.4	cubic metres (m^3)
	cubic feet (ft^3)	.028317	cubic metres (m^3)
	cubic yards (yd^3)	.76455	cubic metres (m^3)
	acre-feet (ac-ft)	1233.5	cubic metres (m^3)
		.0012335	cubic hectometres (hm^3)
		1.233×10^{-6}	cubic kilometres (km^3)
Volume/Time (Flow)	cubic feet per second (ft^3/s)	28.317	litres per second (l/s)
		.028317	cubic metres per second (m^3/s)
	gallons per minute (gal/min)	.06309	litres per second (l/s)
		6.309×10^{-5}	cubic metres per second (m^3/s)
	million gallons per day (mgd)	.043813	cubic metres per second (m^3/s)
Mass	pounds (lb)	.45359	kilograms (kg)
	tons (short, 2,000 lb)	.90718	tonne (t)
		907.18	kilograms (kg)
Power	horsepower (hp)	0.7460	kilowatts (kW)
Pressure	pounds per square inch (psi)	6894.8	pascal (Pa)
Temperature	Degrees Fahrenheit (°F)	$\frac{tF - 32}{1.8} = tC$	Degrees Celsius (°C)

I. SUMMARY

The Sacramento and San Joaquin Rivers, together with their tributaries, drain basins comprising some 11 million hectares (42,500 square miles) tributary to the Delta. Many projects, large and small, utilize the basins' surface water supplies. At least 70 reservoirs of significant size regulate flows in the basins' rivers. Waters are diverted for use by numerous agricultural operations and by several municipalities. All of these uses combine to determine the water remaining in the Delta for local use, Delta outflow to San Francisco Bay, and export by the SWP and the Federal Central Valley Project.

This report deals with operations of the State Water Project at its facilities on the Feather River and in the Delta during calendar year 1976. Other water resources development in the Central Valley is not described in detail. In order to place SWP operations in perspective with other water project developments affecting the Delta, Figure 1 presents a summary of the estimated 1976 surface water supply and use in the Delta and its tributary watersheds. Unimpaired inflows (1)

(1) Unimpaired inflow is calculated by adjusting actual flow to account for the effects of upstream water resources development.

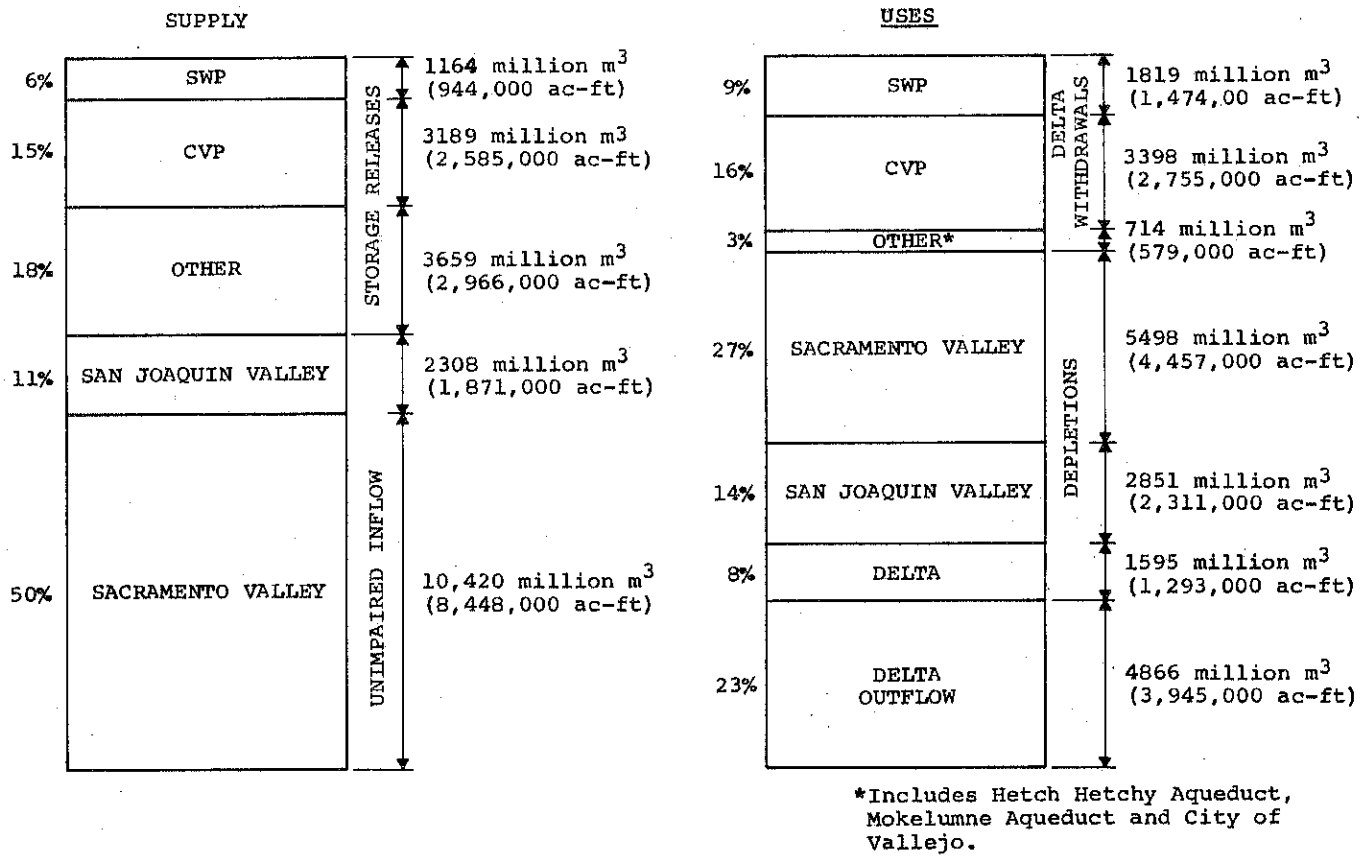


FIGURE 1

ESTIMATED SACRAMENTO-SAN JOAQUIN BASIN WATER BALANCE, 1976

to the Delta, together with storage releases from upstream reservoirs[2], totalled about 20 740 million cubic metres (16,814,000 acre-feet). Storage releases from SWP facilities provided 1 164 million cubic metres (944,000 acre-feet), about 6 percent of the total supply. The Project's net withdrawals from the Delta amounted to 1 819 million cubic metres (1,474,000 acre-feet), about 9 percent of the supply.

In 1976, the State Water Project faced the challenge of the driest hydrologic year since its initial operation in 1967. For the water year ending September 30, 1976, unimpaired runoff in the Feather River basin tributary to the SWP's Oroville Reservoir was 2 297 million cubic metres (1,862,000 acre-feet), or 43 percent of the long-term average. For the entire Sacramento Valley, unimpaired runoff during the water year was about 45 percent of normal. Runoff from October through December 1976 remained at levels well below average.

In December 1975, before the magnitude of the drought had become apparent, the SWP approved schedules for water delivery to its customers calling for 1 688 million cubic metres (1,368,462 acre-feet) of entitlement water and 291 million cubic metres (236,066 acre-feet) of surplus water. Delivery of an additional 644 million cubic metres (522,347 acre-feet) of surplus water was tentatively approved, contingent upon the availability of sufficient supplies. As the year progressed and the drought grew more serious, requests for these additional water deliveries were not approved by the Department of Water Resources. At the end of 1976, actual deliveries of entitlement water totalled 1 694 million cubic metres (1,373,002 acre-feet), while surplus water deliveries totalled 716 million cubic metres (580,110 acre-feet). In making these deliveries, the Project drew upon water stored in reservoirs south of the Delta as well as water withdrawn from the Delta during the year.

Outflows to San Francisco Bay were not always sufficient to achieve water quality objectives established by the State Water Resources Control Board in the Sacramento-San Joaquin Delta. Efforts to maintain these objectives were complicated by actions of the Federal Central Valley Project with respect to coordinated operation of the SWP and FCVP, pursuant to a different set of objectives. In attempting to meet the Basin Plan objectives, the SWP shared fully in outflow maintenance according to a coordination agreement between the two projects; in addition, the Project was operated to maintain an additional 113 million cubic metres (91,408 acre-feet) of Delta outflow.

The Delta water balance for calendar 1976 is illustrated on Figure 2. The total Delta water supply from all sources is estimated at 11 678 million cubic metres (9,467,000 acre-feet). Flow augmentations provided by storage releases from State Water Project facilities accounted for 8 percent of the total Delta supply. SWP net withdrawals from the Delta amounted to 16 percent of the supply. However, Project impacts on Delta flows varied substantially during the year.

Storage in SWP reservoirs was increased by 288 million cubic metres (234,000 acre-feet) during the first three months of 1976, a period of limited early-season storm activity. Beginning in late March, reservoir storage was steadily decreased as the Project augmented Sacramento River inflows to the Delta to control Delta water quality and to supply water for export. SWP storage releases during the last nine months of the year totalled 1 234 million cubic metres (1,000,000 acre-feet).

SWP net withdrawals from the Delta to-

(2) Storage releases are releases in excess of reservoir inflows. They represent additions to the water supply that would have been available in the absence of the reservoirs.

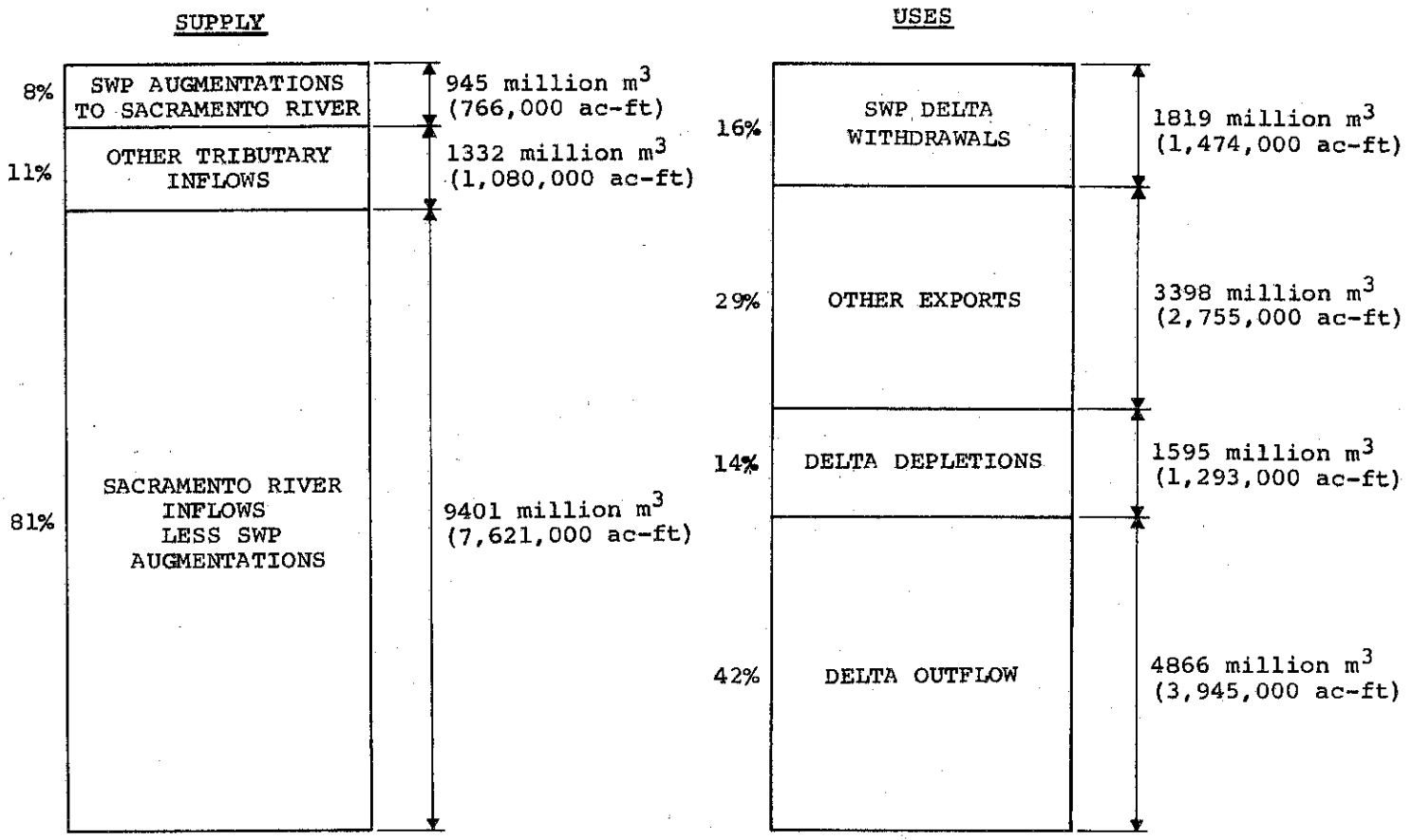


FIGURE 2

ESTIMATED DELTA WATER BALANCE, 1976

talled 1 819 million cubic metres (1,474,000 acre-feet) in 1976. Withdrawal rates were relatively high from January through March when the Project was exporting unstored Valley runoff. Withdrawals were sharply curtailed at the end of March in coordination with simultaneous releases from Project storage in an effort to meet Delta water quality objectives during the striped bass spawning period. Reduced Delta withdrawal rates continued through mid-July, at first for the protection of young striped bass in the Delta, and later as a consequence of an interruption in California Aqueduct service south of the Delta. Net Delta withdrawals were then increased for about three months. However, in October the SWP again lowered its export pumping as ocean salinity intrusion began a rapid, steady advance into the Delta.

The combination of SWP reservoir-storage and release operations, plus net Delta withdrawals, had varying effects on the rate of Delta outflow. From January through March, while water was being simultaneously stored in the reservoirs and withdrawn from the Delta, the Project diminished Delta outflow by 1 085 million cubic metres (880,000 acre-feet). From April through mid-August, the SWP augmented outflow by 395 million cubic metres (320,000 acre-feet). For the next eight weeks, the Project reduced outflows by 224 million cubic metres (181,000 acre-feet) as Delta export pumping was increased in an effort to recover water not pumped during a period when California Aqueduct service was interrupted. Project effects on outflow from mid-October through the end of 1976 were relatively small, with a net augmentation for the

period of 40 million cubic metres (33,000 acre-feet).

The Project undertook two special measures for modification of Delta flow patterns during the year to provide both water savings and quality improvement. In September, a temporary closure, as shown in Figures 9 and 14 was installed in Sutter Slough, west of the Sacramento River. The closure served to increase the transfer of Sacramento River water through the central Delta, reducing flow reversals in the San Joaquin River. By retarding the intrusion of ocean salinity into the San Joaquin, the closure conserved an estimated 74 million cubic metres (60,000 acre-feet) of water. In November, a temporary closure was placed in Old River, as shown in Figures 9 and 15, east of the Project's Delta Pumping Plant, for the protection of the fall salmon run on the San Joaquin River. The Old River closure directed a portion of the inflowing San Joaquin River to the north, toward Stockton, providing flushing action at the location of an acute dissolved oxygen depression in the Stockton Ship Channel.

Salinity conditions in the Sacramento-San Joaquin Delta reflected the severity of the drought which began in 1976. Figure 3 shows the maximum landward extent of ocean salinity intrusion during the year as measured by chloride concentrations of 1 000 mg/l. In 1976, water with 1 000 mg/l chlorides reached nearly to Rio Vista on the Sacramento River and to the junction with Threemile Slough on the San Joaquin River. Figure 3 shows that this salinity occurred several miles further upstream than it did in

Areal View of Sutter Slough and Temporary Closure

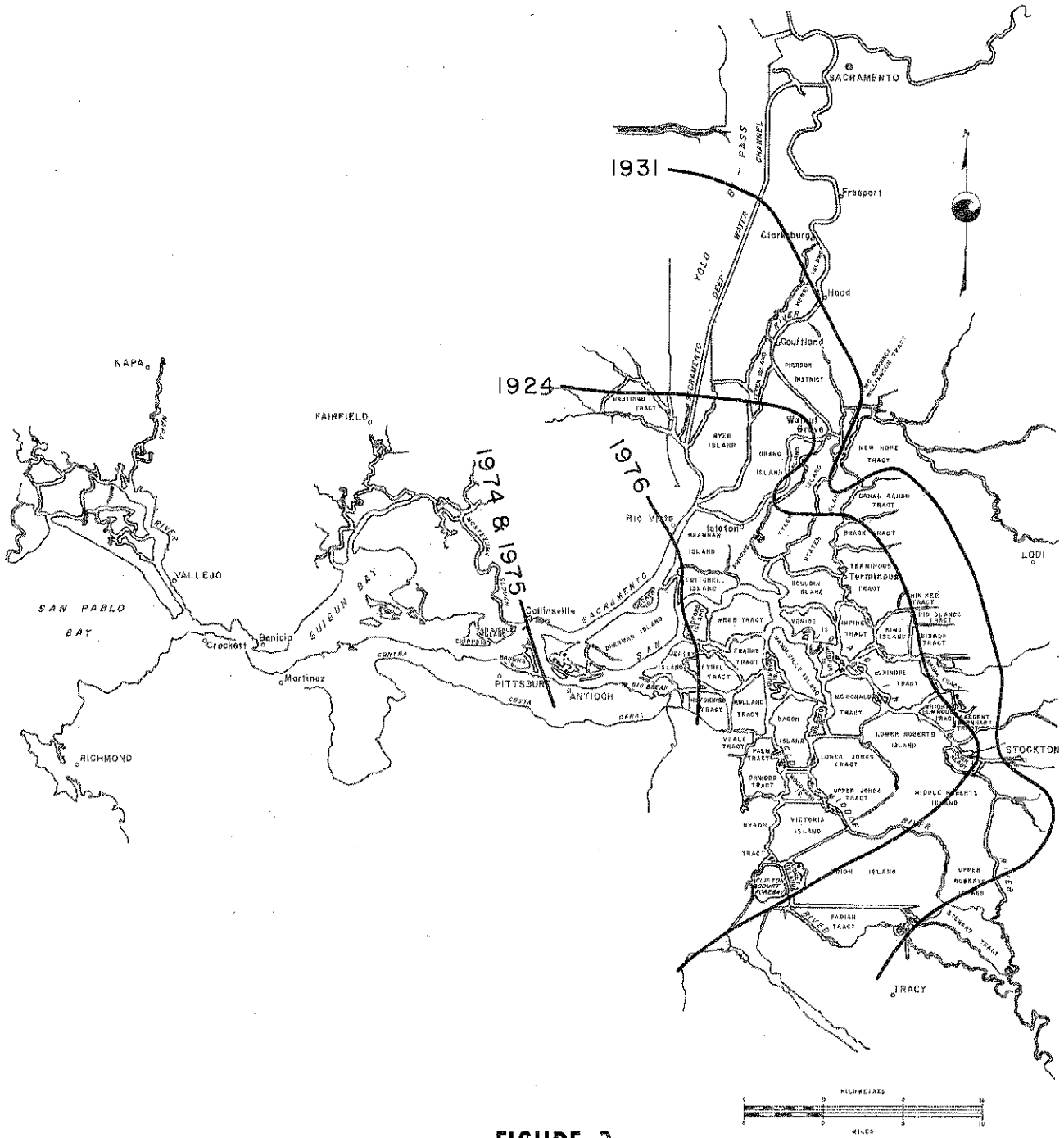


FIGURE 3

MAXIMUM ANNUAL SALINITY INTRUSION
1000 mg/l CHLORIDE, 1½ HOURS
AFTER HIGH HIGH TIDE

1974 and 1975, but was controlled to a location not nearly so far upstream as in the previous drought years of 1924 and 1931, prior to construction of the State Water Project and the Federal Central Valley Project.

Delta salinity objectives and operating criteria applicable to the State Water Project have been established by the State Water Resources Control Board both in the Project's water rights permits and in the Board's Water Quality Control Plans. Some objectives were achieved during 1976; others were not fully achieved. Most periods of nonachievement occurred near the end of the year as drought conditions in the Central Valley continued. The criteria, and the degree to which they were achieved, are summarized as follows:

1. Criteria for the Protection of Delta Agriculture:

   In the interior Delta, total dissolved solids objectives at Terminous on Little Potato Slough, Rio Vista on the Sacramento River, San Andreas Landing on the San Joaquin River, and Clifton Court Ferry on Old River were achieved.

   In the western Delta, a "spring flushing" objective limiting chloride concentrations at Emmaton on the Sacramento River, and at Jersey Point on the San Joaquin River during April and May, was achieved. A limitation on electrical conductivity at Blind Point on the San Joaquin River from April through July was maintained, but the August through December limitation of 3 100 microsiemens/cm (14-day average) was not maintained during the last three weeks of December when conductivity reached a peak of 3 339 microsiemens/cm. The year-long chloride concentration limit at Jersey Point was maintained. At Emmaton, the chloride limit of 1 000 mg/l (10-day average) was maintained from the beginning of January through December 5. On December 6, the chloride level rose above 1 000 mg/l and remained above the objective for the remainder of the year, reaching a maximum of 1 321 mg/l.

   An operational criterion contained in water rights permits for the SWP prohibits additions to reservoir storage or direct Delta exports during April, May, and June, whenever high-tide chloride concentrations at Blind Point on the San Joaquin River exceed 250 mg/l. Blind Point chlorides exceeded this level during most of the three months, and the Project was operated in conformance with the criterion.

2. Criteria for the Protection of Municipal and Industrial Use:

   At the Contra Costa Canal Intake on Rock Slough, an objective limiting concentrations of both chlorides and total dissolved solids was achieved. An objective for mean daily total dissolved solids concentration for any 14 consecutive days at Antioch, on the San Joaquin River, is to maintain a limit of 450 mg/l for at least 120 days during a dry water year. TDS levels remained below the limit from October 1, 1975, through January 25, 1976, a period of 117 days, 3 days less than the period called for in the objective.

3. Criteria for the Protection of Fish and Wildlife:

   At Antioch, an objective for the protection of striped bass spawning limits the 14-day average electrical conductivity to 1 500 microsiemens/cm for five weeks during the spring. This limit was exceeded for 26 days of the five-week period beginning March 29, 1976, as conductivity reached a maximum of 2 225 microsiemens/cm. A related objective at Prisoner's Point on the San Joaquin River was achieved, however.

   At Chipps Island, the 14-day average

chloride concentration is limited to 4 000 mg/l for the protection of Neomysis, a striped-bass food supply. This limit was maintained from January 1 through October 30, 1976.

Chloride levels rose above the limit for 63 days from October 31 through the end of the year, when the 14-day average chloride concentration reached a maximum of 4 755 mg/l.

A limitation on total dissolved solids in the vicinity of Suisun Marsh was maintained, as indicated by measurements at Port Chicago, near Suisun Bay.

The State Water Project continued its comprehensive Delta water quality monitoring program. A new laboratory boat, the M.V. San Carlos, was placed in service in March as an integral part of the ongoing effort to assemble detailed water-quality data for use in project planning.

The Project continued its participation in the Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary, the "Four-Agency" program, in cooperation with the Department of Fish and Game, the U. S. Fish and Wildlife Service, and the Bureau of Reclamation. Measurements in the Delta showed that in the drought year, the populations of algae, Neomysis, young striped bass, and American shad were among the lowest observed since regular surveys began.

II. 1975-76 WATER SUPPLY

California's "water year" begins on October 1 and continues through September 30 of the following calendar year. This definition of the water year recognizes that most of the annual water supply in the form of rain and snow is usually received between October and April, while water demands are at their peak during the irrigation season from April through September.

Water year 1975-76 began with above-normal precipitation at most stations in the Sacramento Valley. For example, October 1975 precipitation at Shasta Dam, in the northern Valley, was 199 millimetres (7.83 inches), about double the normal amount. At the southern end of the Valley, Sacramento received 59 millimetres (2.32 inches) of rain in October, 255 percent of normal. In November, a persistent weather system deflected the storms typical of a California winter to the north. By December 1, cumulative precipitation had declined to near-normal levels. At Shasta Dam, the October-November total was 77 percent of normal, while that at Sacramento was 109 percent of normal.

The State Water Project schedules deliveries to its customers for the coming year by December 1, early in the water year before the total supply is known. Early scheduling is especially important to agricultural users, who must plan the commitment of substantial resources to the planting of spring crops. Schedules for the first six months of 1976 were approved December 1, 1975, based on the water supply picture at that time. The schedules called for delivery of 1 688 million cubic metres (1,368,462 acre-feet) of entitlement water and 291 million cubic metres (236,000 acre-feet) of surplus water. Tentative approval was given for additional surplus deliveries of 644 million cubic metres (522,347 acre-feet) during the latter part of 1976, contingent upon the availability of sufficient supplies.

As 1976 continued, precipitation remained well below normal. By April 1, the accumulated snowpack in the Sacramento Valley was less than 50 percent of normal. Snowmelt was underway, and by May 1, with the precipitation season nearly over, the snowpack in the Sacramento watershed was 40 percent of normal. May 1 forecasts of the year's inflow to major Sacramento Valley reservoirs indicated that total runoff would be less than half the normal amount. These estimates were generally within a few percent of the values observed later.

According to a long-used system of classifying water years on the basis of total unimpaired inflow to Shasta Reservoir, which was 4 453 million cubic metres (3,610,000 acre-feet). 1975-76 was a "dry" water year, rather than a "critical" one. This classification is significant to SWP operations, because it is used by the State Water Resources Control Board to determine the degree to which certain Delta water quality objectives may be relaxed. The Shasta inflow definition, however, is limited to runoff at a single station; it does not fully reveal the severity of the 1976 drought in relation to other major water conservation facilities in the Sacramento River basin, since unusually heavy natural flows of ground water augment seasonal precipitation inflow to Shasta. The Department of Water Resources has developed a more broadly based classification system that uses unimpaired runoff at four key points in the Sacramento Valley, shown on Table 1.

According to the DWR classification system, when total unimpaired runoff at the four stations shown on Table 1 falls below 12 852 million cubic metres (10,200,000 acre-feet) the water year is classified as "critical". The 1976 total for these stations was 10 108 million cubic metres (8,195,000 acre-feet), well below the limit of "critical" years. 1976, the third driest year of record,

TABLE 1

1976 WATER YEAR UNIMPAIRED RUNOFF

Station	Runoff		Percent of Normal
	million cubic metres	acre-feet	
Sacramento River above Bend Bridge	5,982	4,850,000	61
Feather River inflow to Oroville	2,307	1,870,000	43
Yuba River at Smartville	851	690,000	30
American River inflow to Folsom	968	785,000	31
Total	10,108	8,195,000	48

was certainly critical from the standpoint of the SWP storage facility at Oroville. Inflow to Oroville Reservoir was 43 percent of the long-term average.

Given the water supply picture presented above, the State Water Project's ability to meet its water supply commitments and comply with water quality objectives in the Delta was severely stressed during calendar 1976. Deliveries of surplus water were curtailed during the year, and actual deliveries to Project customers totalled 1 694 million cubic metres (1,373,002 acre-feet) of entitlement water and 716 million cubic metres (580,110 acre-feet) of surplus water.

Water quality control efforts in the Delta were complicated by actions of the Federal Central Valley Project with respect to its responsibilities for sharing in the maintenance of Delta outflow. The State Water Project operated so as to provide its full share of Delta outflow, as called for in a coordinated operations agreement between the SWP and FCVP. However, since some Delta water quality objectives not specified in the agreement were not fully achieved, the SWP was also operated to maintain an additional 113 million cubic metres (91,408 acre-feet) of outflow, which the FCVP held to be outside of its responsibility to provide under the operations agreement. As discussed in Chapter III, the SWP does not concur, and holds this additional amount of outflow to have been part of the FCVP share.

III. SWP WATER OPERATIONS IN THE DELTA

The State Water Project's reservoir facilities in the Feather River basin, and its diversion works in the southern Delta, are operated in a coordinated manner to achieve multiple objectives. Within the Delta, these objectives include (1) the transfer of water to the diversion works for export, and (2) the control of Delta water quality to meet, during 1976, criteria in the project's water rights D-1275 and D-1291, as well as objectives in the State Water Resources Control Board's basin plans.

Reservoir operations regulate downstream flows and may increase or decrease inflows to the Delta. The combination of reservoir operations and Project exports results in the redistribution of flows within the Delta, accompanied by increases or decreases in the rate of Delta outflow. In addition, from time to time the Project undertakes temporary measures within the Delta to further modify flow distributions for special purposes. The following discussion describes how State Water Project operations affected Delta flows during 1976. Delta water quality during the year is discussed in Chapter IV.

Sacramento River Inflows to Delta

Of the streams tributary to the Delta, the Sacramento River is by far the largest, contributing an average of about 85 to 90 percent of total annual Delta inflow. Sacramento River inflow is affected by the activities of many water users within the Valley and by operation of a number of reservoirs, including the Feather River facilities of the State Water Project.

At its point of entry into the Delta, the Sacramento River is influenced by tidal action. Direct measurement of its flow rate is therefore rarely attempted. Estimates of the flow are prepared by the U. S. Geological Survey using a river flow model based upon measurements from a pair of water stage recorders, one in the vicinity of the City of Sacramento and the other near Freeport. Completion of these estimates requires a period of time, however. For its day-to-day operations, the State Water Project therefore prepares flow estimates based on the summation of measurements at upstream, nontidal stations on the Sacramento and American Rivers.

The two estimates of Sacramento River flow do not always agree. However, considering that the USGS estimate is relatively accurate, while the SWP estimate is only approximate, the extent of agreement is remarkable. Figure 4 presents weekly average Sacramento River inflows for 1976 as estimated by both procedures. According to the Project Operation Estimate, Sacramento River inflows totalled 10 248 million cubic metres (8,307,000 acre-feet) during the year, while total inflows computed using the U. S. Geological Survey Estimate were 10 346 million cubic metres (8,387,000 acre-feet).

Flow measurement differences notwithstanding, the State Water Project had significant seasonal effects on the Sacramento River, as described in the following paragraphs.

SWP Effects on Sacramento River Inflows to Delta

The State Water Project contributes to modification of Delta inflow through operation of the Oroville-Thermalito Complex, as well as Antelope and Frenchman Lakes, and Lake Davis, shown on Figure 5. When inflows to these SWP facilities are greater than total releases, the Project is storing water and reducing Feather River flows. Conversely, when releases are greater than inflows, the Project is augmenting flow in the Feather River. The effects of Project operations on Feather River flows are transferred downstream to the Sacramento River. After a time lag of approximately two days, Project flow modifications are

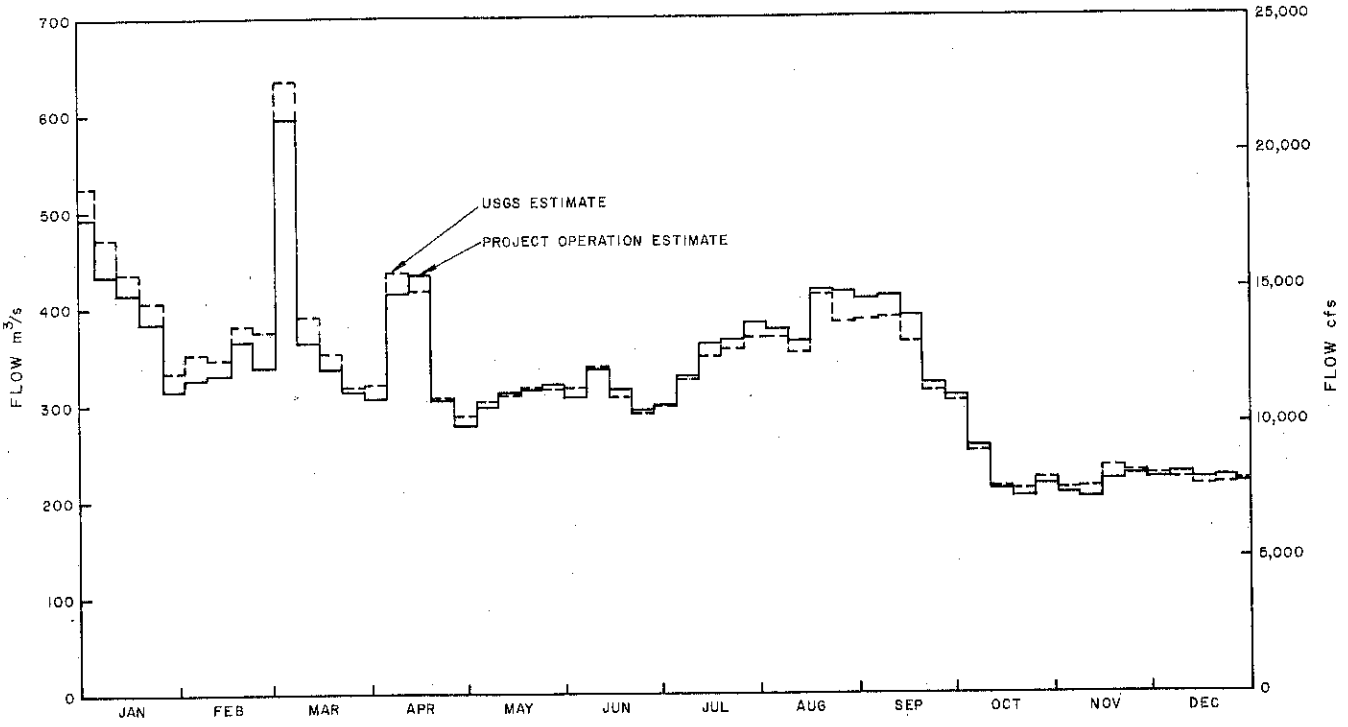


FIGURE 4

SACRAMENTO RIVER INFLOWS - 1976

felt in the Sacramento River at the Delta.

The effects of SWP operations on Delta inflows are calculated by comparing estimates of the flow released from the Oroville-Thermalito facilities with the flow that would have occurred in the absence of the State Water Project. "With Project" flow is the sum of project releases directly to the Feather River and the estimated return flow from the Project's deliveries to the Feather River Service Area.(1) FRSA return flow is estimated by applying the following factors to water deliveries:

Month	Estimated Return Flow, percent of water delivered
January	23
February	23
March	23
April	23
May	28.5
June	17.5
July	12
August	17.5
September	67
October	56
November	23
December	23

(1) The Project delivers water to the Sutter-Butte, Western, Richvale, and Palermo Canals, and the PGandE Lateral. Users served by these deliveries have water rights which predate rights of the SWP. Prior to construction of the SWP facilities, these users diverted water directly from the Feather River.

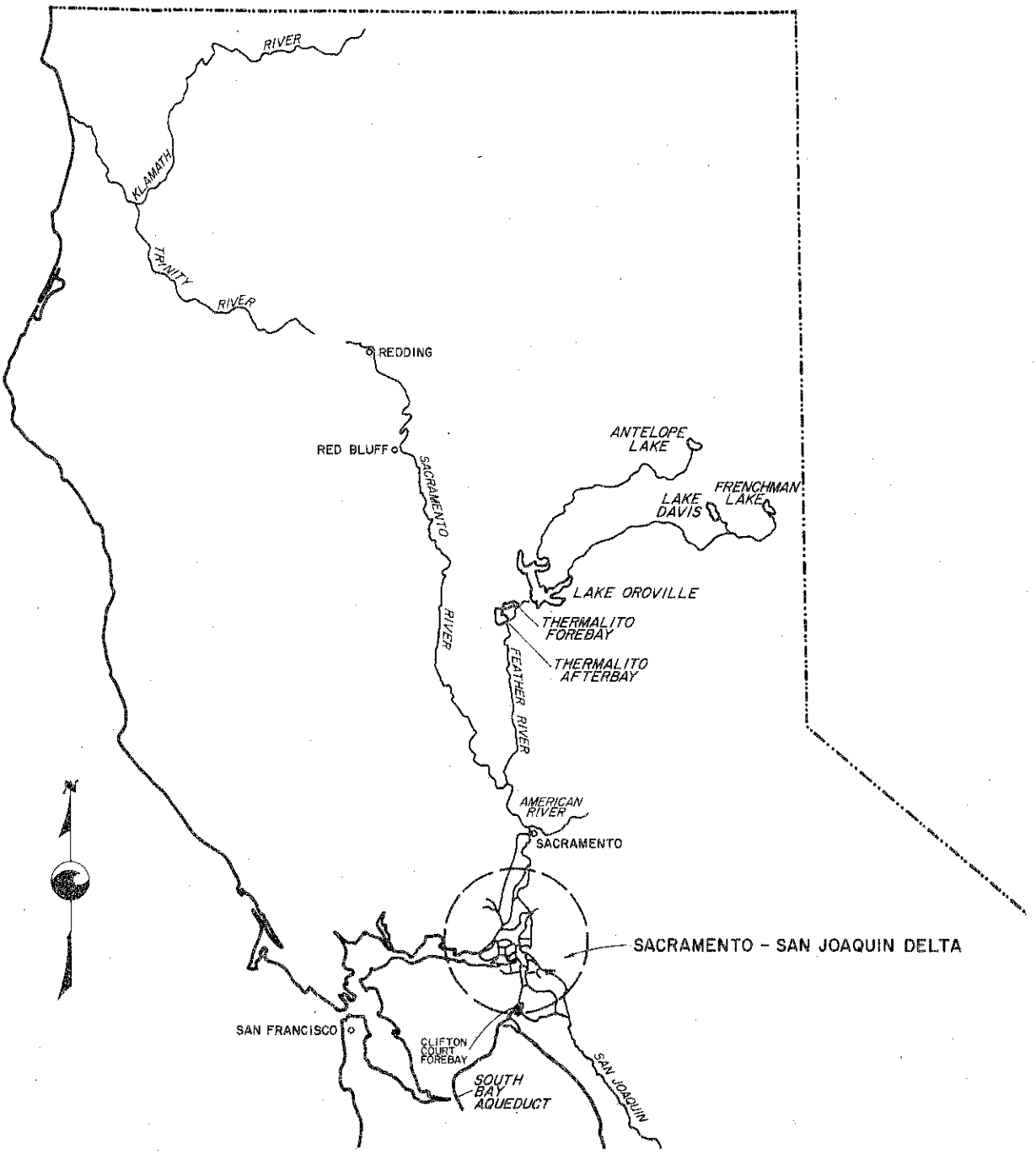
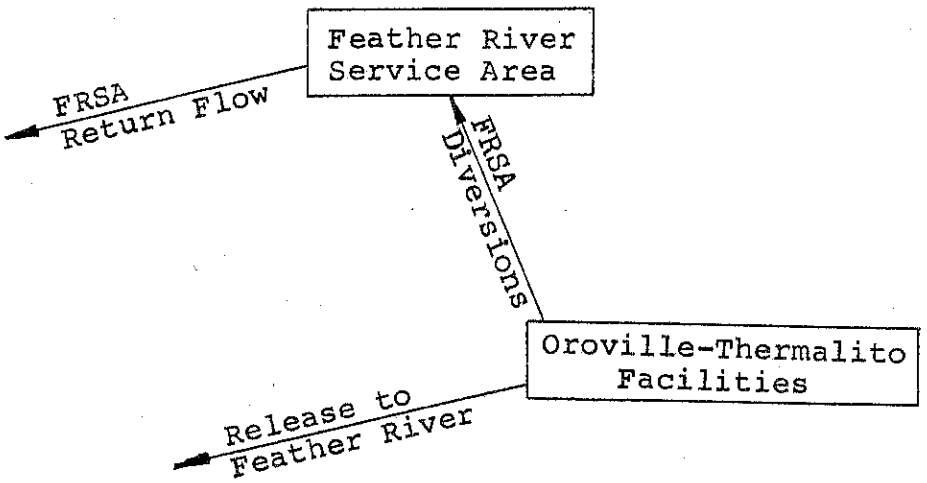


FIGURE 5

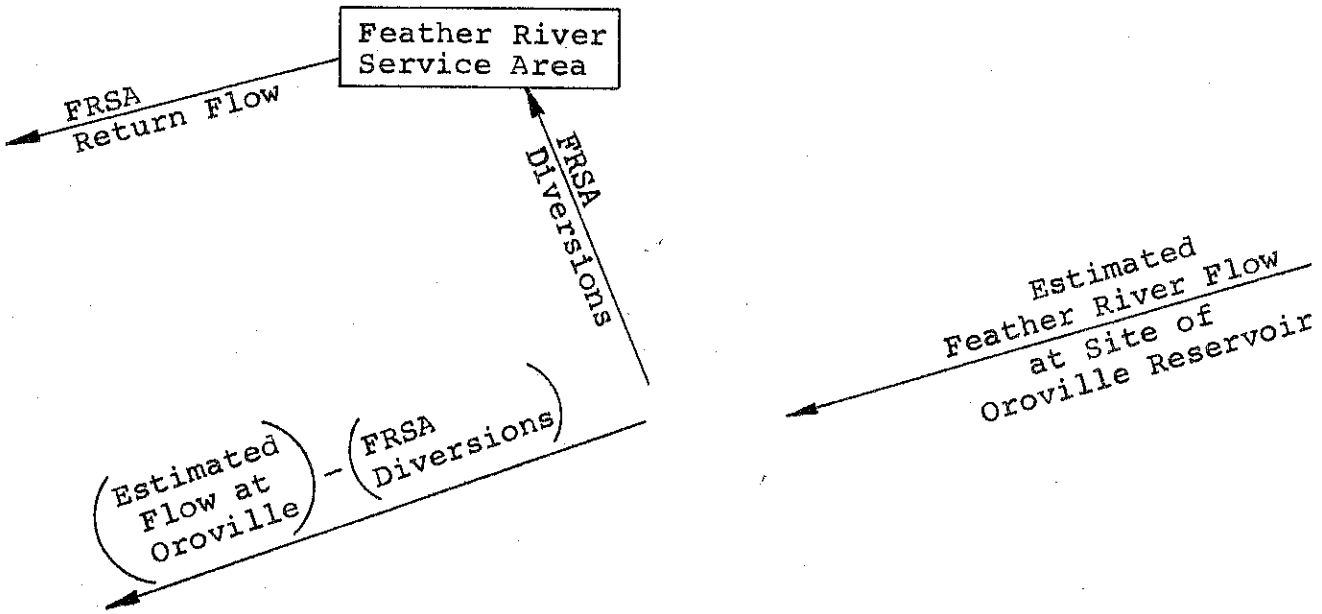
STATE WATER PROJECT FACILITIES - LOCATION MAP

"WITH PROJECT"



"With Project" Flow = Releases to Feather River + FRSA Return Flow

"WITHOUT PROJECT"



"Without Project" Flow = Inflow to Oroville - FRSA Diversions + FRSA Return Flow

FIGURE 6
STATE WATER PROJECT FACILITIES
FEATHER RIVER FACILITIES-SCHEMATIC

"Without Project" flow is the sum of (1) the computed inflow to Oroville Reservoir adjusted to account for operations at SWP reservoirs on the upper Feather River, and (2) estimated return flows from the FRSA, minus diversions to the FRSA. In the "Without Project" case, FRSA diversions are taken as the water actually received by FRSA or inflow to Oroville Reservoir, whichever is less. The procedures for calculating "With Project" and "Without Project" flows are illustrated schematically on Figure 6.

Project effects on Delta inflow at any time are estimated by subtracting "Without Project" flow from "With Project" flow, and applying an adjustment which reflects the approximate travel time between Oroville and the Delta.

Feather River basin flows during 1976 are shown on Figure 7. "With Project" flows and "Without Project" flows are presented on a weekly average basis, adjusted for the Oroville-to-Delta travel time. The differences between the two flows, shown on Figure 8, represent SWP effects on Sacramento River inflow to the Delta.

During 1976, the State Water Project provided augmentations to Sacramento River inflows to the Delta of 945 million cubic metres (766,000 acre-feet) through net releases from storage at its Feather River facilities. These augmentations represented about 9 percent of the total Sacramento River inflow. Note, however, that SWP effects varied substantially within the year.

From January 1 through March 28, Sacramento River inflows totalled 2 896 million cubic metres (2,348,000 acre-feet) according to the Project Operation Estimate. During this period, inflows to the SWP facilities of Oroville were at their peaks for the year, and the Project thus stored water, reducing Delta inflows by 288 million cubic metres (234,000 acre-feet).

From March 29 through the end of 1976, SWP releases exceeded inflows to Oroville Reservoir as storage in the Feather River facilities was steadily decreased. During those nine months, the State Water Project augmented Sacramento River inflows by 1 234 million cubic metres

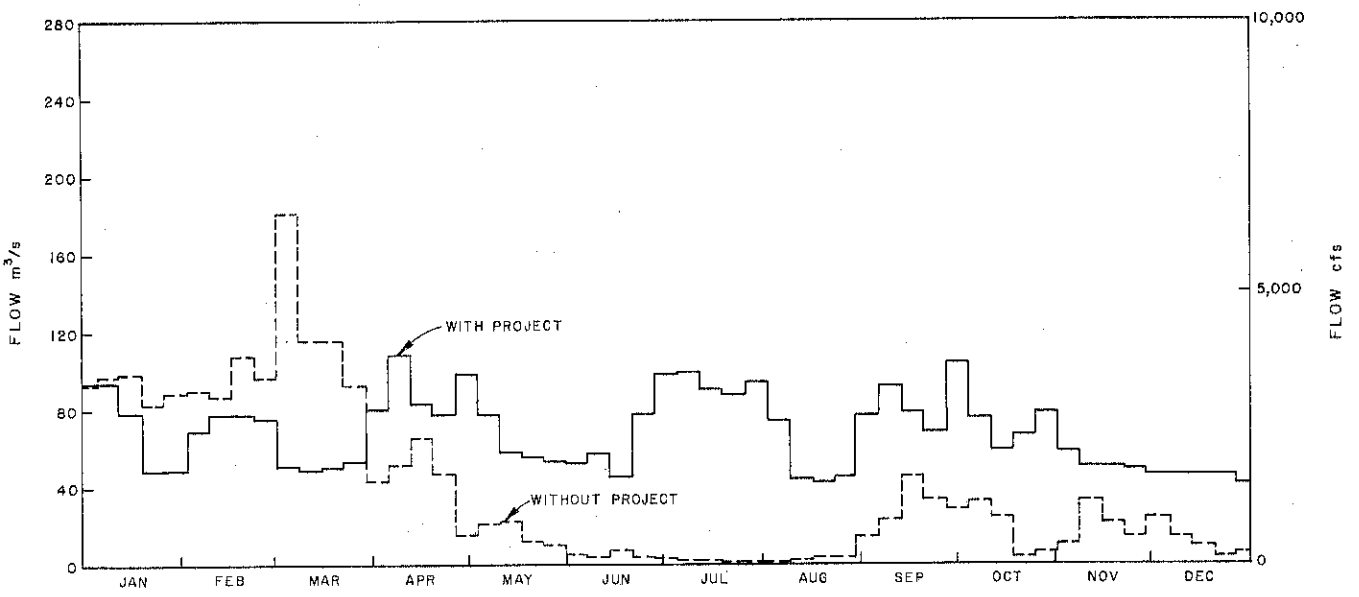


FIGURE 7

SWP FEATHER RIVER OPERATIONS - 1976

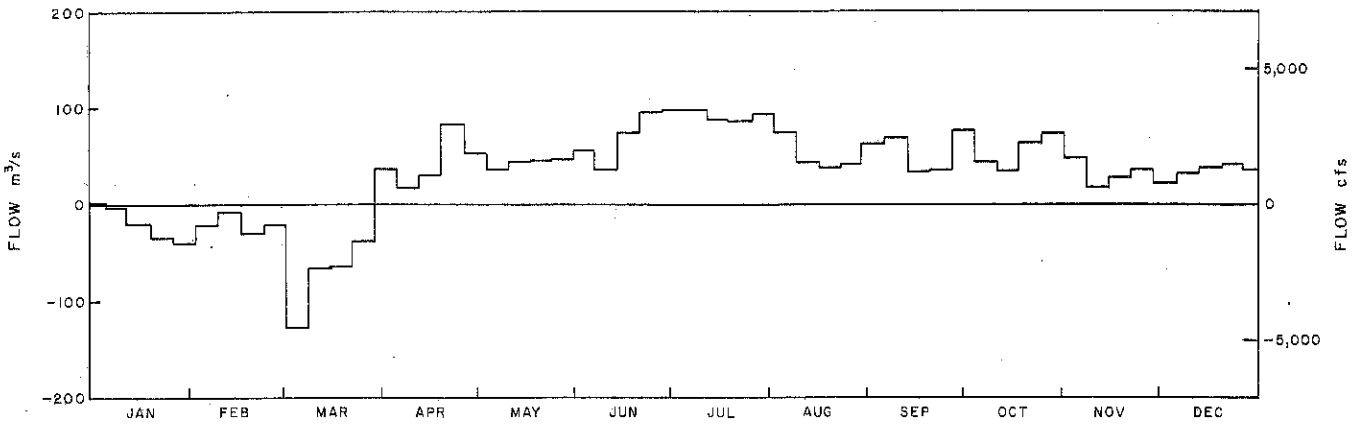


FIGURE 8

SWP EFFECTS ON SACRAMENTO RIVER INFLOWS TO DELTA - 1976

(1,000,000 acre-feet). The augmentations, which were at maximum values during mid-summer, totalled about 17 percent of the Sacramento inflow for the nine-month period, which was 7 351 million cubic metres (5,959,000 acre-feet) according to the Project Operation Estimate.

Delta Outflow

The Sacramento-San Joaquin Delta, shown on Figure 9, is a portion of the tidal estuary that links the fresh waters of Central Valley rivers and the marine waters of San Francisco Bay and the Pacific Ocean. The vigorous action of ocean tides tends to push Bay salt water upstream into the Delta. The tidal force is opposed by Delta outflow, which carries intruding ocean salts back downstream toward the Bay. These two opposing forces, tidal mixing and Delta outflow, act together to form a transition zone between fresh and salt waters. The extent to which ocean salinity intrudes into the Delta is determined by variations in the Delta outflow, and by the manner in which flow is distributed among the Delta waterways. Daily fluctuations in salinity are also caused by changing tide and weather conditions.

A primary purpose of State Water Project operations is the control of salinity intrusion within the Delta. The Project strives to achieve this objective through its contributions to the regulation of outflow. Therefore, especially during dry years such as 1976, day-to-day operational decisions depend upon timely information on the daily outflow rate, tides, and salinity conditions. This information is compiled into a report of "Daily Delta Water Quality Conditions", and made available within 24 hours for project operation decision-making at the beginning of the following day. An example of the daily Delta water-quality conditions report is included as Addendum 2 to this report.

The daily report includes, in addition to telemetered salinity data from "control" locations throughout the Delta, daily tidal-stage measurements at Antioch in the western Delta, and the daily quantity of Delta fresh water outflow. Unfortunately, a practical method for the direct measurement of Delta outflow has not yet been perfected. Instead, the required information must be derived from estimates.

In concept, estimating Delta outflow is a relatively simple procedure. Tributary inflows and rainfall are summed. Water withdrawals from the Delta channels, including exports of the SWP and FCVP and

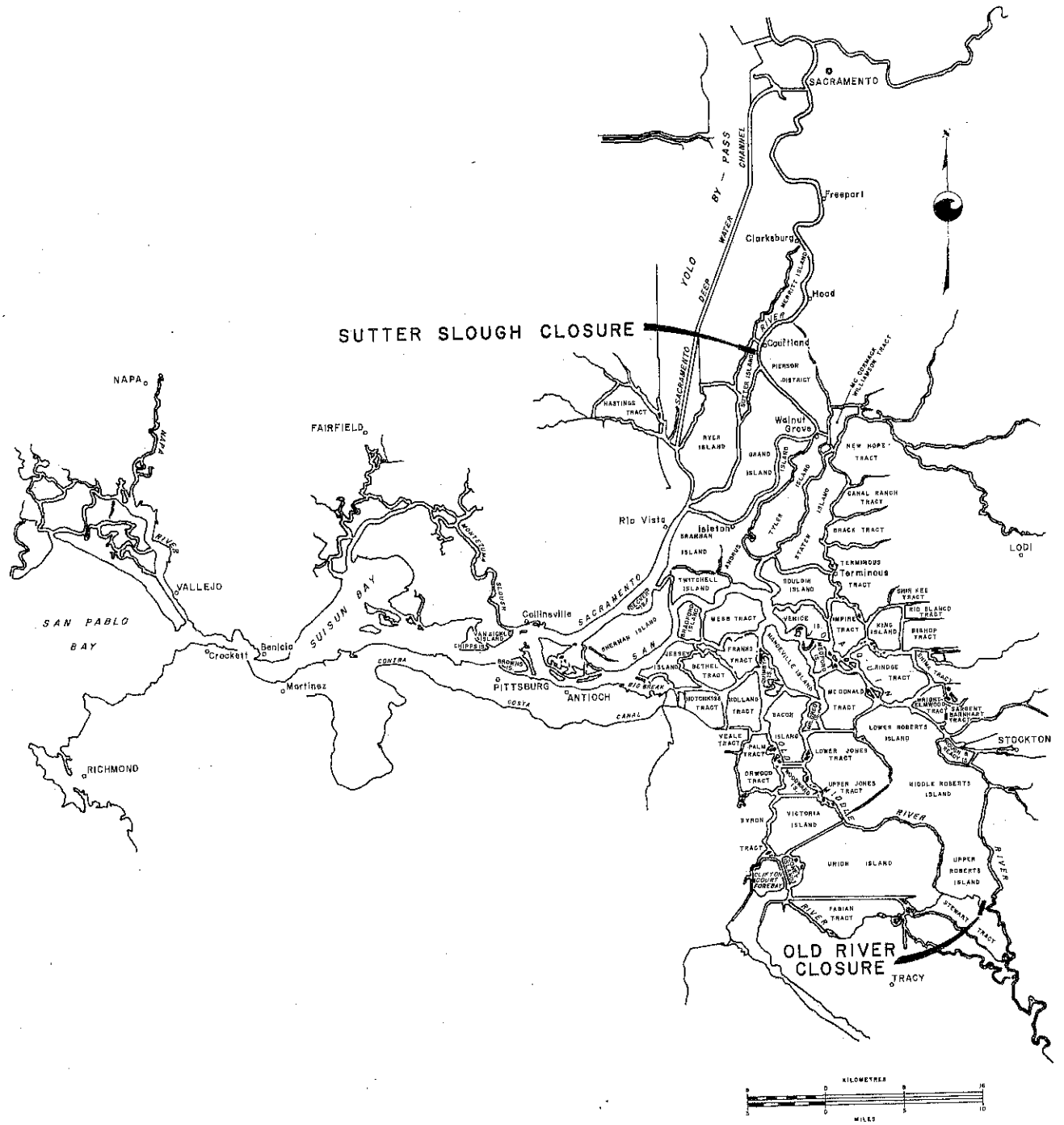


FIGURE 9

SACRAMENTO-SAN JOAQUIN DELTA

estimated net water use within the Delta, are deducted from total inflows to provide the required estimate of outflow to the Bay.

In practice, confident estimates of outflow are difficult to obtain because of uncertainty about the magnitude of major components of both inflows and withdrawals. It has already been shown that there is some uncertainty as to the inflow from the largest Delta tributary, the Sacramento River. With respect to withdrawals, the diversions and return-flow discharges made during the process of irrigating the Delta's extensive agricultural lands are unmeasured. These net uses by agriculture, usually known as channel depletions, are substantial. Several different estimates of channel depletions, based on crop pattern surveys and average use rates, are available.

For purposes of its daily operations, the State Water Project utilizes an outflow estimate known as the Delta outflow index. The index is based on estimated inflows from the Sacramento and San Joaquin Rivers, estimated long-term average Delta channel depletions and rainfall patterns, and measured exports by the SWP and the Federal Central Valley Project. Figure 10 presents variations in the Delta outflow index during 1976 on a weekly average basis.

To illustrate the differences among alternative methods of estimating outflow, Figure 10 also shows a "calculated Delta outflow" prepared by the staff of the Department of Water Resources. The calculated outflow differs from the outflow index in that it is based upon inflows from all Delta tributaries, observed rainfall, and channel-depletion estimates derived from current crop surveys.

According to the Delta outflow index, outflow during 1976 totalled 4 760 million cubic metres (3,859,000 acre-feet).

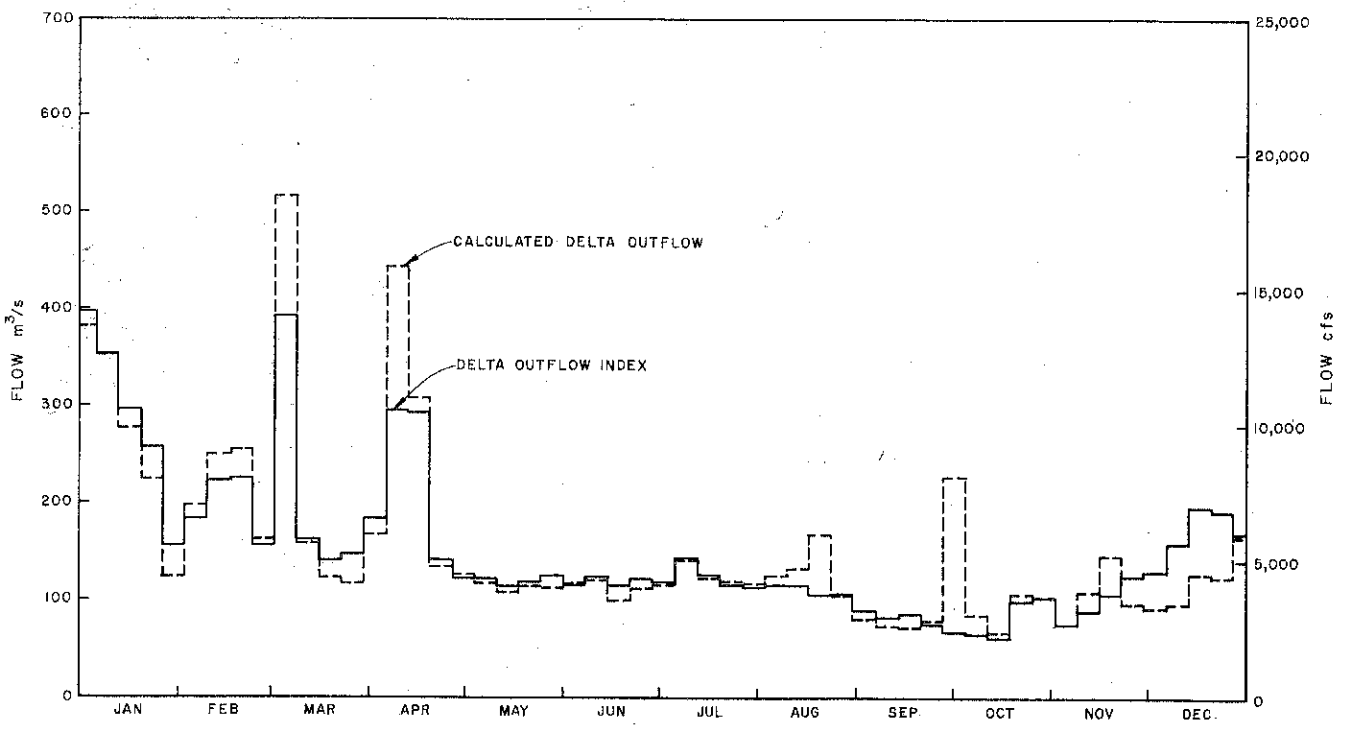


FIGURE 10

DELTA OUTFLOW, 1976

Maximum outflows occurred early in the year, and from January 1 through April 18 the index totalled 2 228 million cubic metres (1,806,000 acre-feet), 47 percent of the annual total. During the remainder of the year, Delta outflow was controlled by the combined operations of the SWP and FCVP. For the 8-1/2 months from April 19 through December 31, the Delta outflow index totalled 2 532 million cubic metres (2,053,000 acre-feet) and the weekly average rate ranged between 61-195 cubic metres (2,150-6,880 cubic feet) per second.

The calculated Delta outflow for 1976 totalled 4 866 million cubic metres (3,945,000 acre-feet). The total calculated outflow was greater than the outflow index by 106 million cubic metres (86,000 acre-feet). The validity of both outflow estimates is brought under question when they are considered in connection with water quality observations, as discussed in Chapter IV.

The two estimates are in general agreement during much of the year. However, the estimates differ markedly during storm periods that depart from the long-term patterns of rainfall reflected in the index. Significant differences also occurred during the final weeks of 1976. From November 8 through December 31, the Delta outflow index averaged 144 cubic metres (5,094 cubic feet) per second. During the same period the calculated Delta outflow averaged 117 cubic metres (4,138 cubic feet) per second. The Delta outflow index was thus higher than the calculated outflow by an average of 27 cubic metres (956 cubic feet) per second for nearly two months. These deviations are of some interest since, as will be shown later, certain Delta water quality standards related directly to outflow were not achieved during November and December.

The uncertainties illustrated by the differences between the outflow estimates demonstrate a critical problem facing operators of the State Water Project, especially during dry years when it is essential to conserve dwindling water supplies. During drought periods, operational decisions must balance with special care the day-to-day requirements for water supply and water quality control in the Delta against the anticipated needs of subsequent weeks and months. At best, those needs are imprecisely known. Delta consumptive uses are subject to variations beyond the control of Project operators. In the longer term, and beyond the concern only of Project operations, the problem of preparing quantitative estimates of both consumptive uses and Delta outflow is shared by everyone responsible for planning future allocations of Central Valley water resources.

SWP Withdrawals from the Delta

Withdrawals of water from the Delta into the State Water Project's Clifton Court Forebay serve several purposes. In addition to meeting Project demands for export at the Delta Pumping Plant, water diverted into the forebay is used to supply the Byron-Bethany Irrigation District which diverted directly from the Delta prior to construction of the forebay. On occasion during 1976, the Project also pumped quantities of water for the Federal Central Valley Project through SWP facilities. In 1976, the FCVP's nearby Tracy Pumping Plant was used temporarily during July and August to pump water for the SWP during repairs to the California Aqueduct south of the Delta.

SWP net withdrawals from the Delta during 1976 are shown on Figure 11 in terms of weekly average flow rates. The data presented include withdrawals for Project purposes through both SWP and FCVP facilities, but exclude water delivered by SWP to the Byron-Bethany Irrigation District and to the Federal Central Valley Project. Project net Delta withdrawals for 1976 totalled 1 819 million cubic metres (1,474,000 acre-feet). As shown on Figure 11, the rate of withdrawal varied significantly during the year.

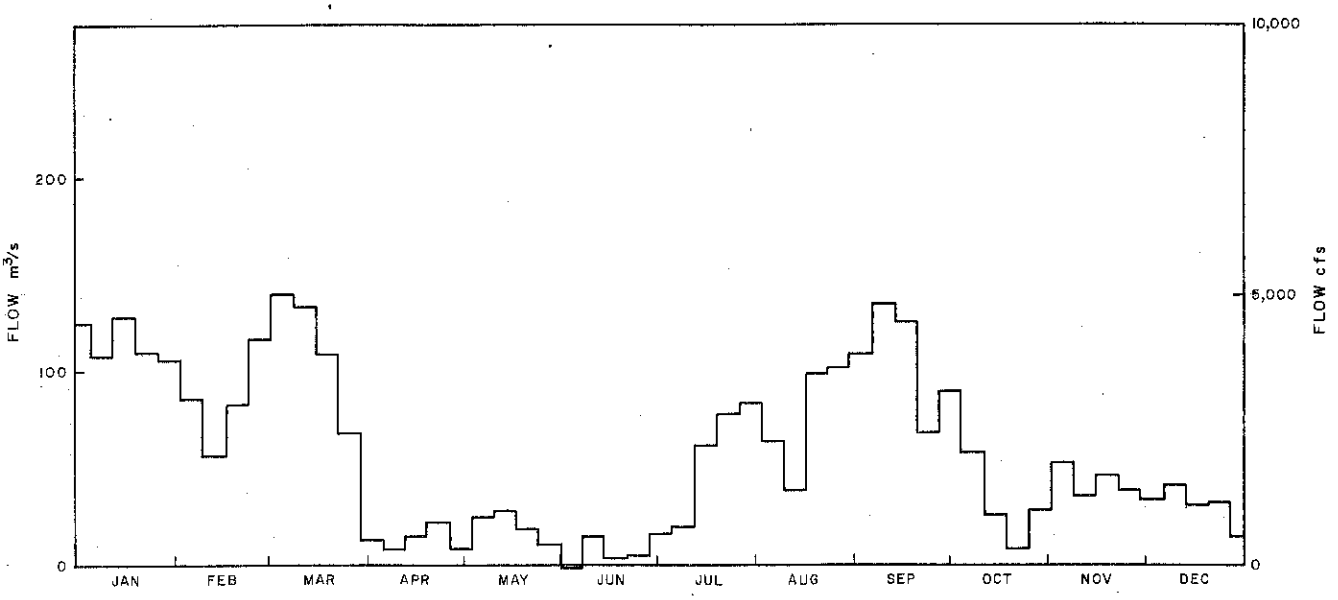


FIGURE 11

SWP NET WITHDRAWALS FROM DELTA - 1976

Between January 1 and March 28, 1976, the Project withdrew a total of 797 million cubic metres (646,00 acre-feet) from the Delta. In late March, a Delta water-quality limitation related to striped-bass spawning was exceeded, and the State Water Project sharply curtailed its diversions, simultaneously increasing releases from Oroville Reservoir.

SWP withdrawals continued at relatively low levels for the next three months. To protect young striped bass, diversions were deliberately reduced for five weeks beginning May 22. In late June, damage to the California Aqueduct south of the Delta resulted in further extension of the period of lowered exports. From March 29 through July 4, 1976, SWP withdrawals from the Delta totalled 112 million cubic metres (91,000 acre-feet).

During the summer and early fall, SWP withdrawals were increased. In July and August, while the California Aqueduct was being repaired, the FCVP's Tracy Pumping Plant supplemented limited exports through SWP facilities by pumping 170 million cubic metres (139,160 acre-feet) for the State Water Project. Following completion of aqueduct repairs in mid-August, the SWP increased its diversions for several weeks in an effort to recover water not pumped during the interruption in Aqueduct service. From July 5 through October 10, SWP withdrawals from the Delta, including water pumped for the SWP by the FCVP, totalled 674 million cubic metres (546,000 acre-feet).

During the final months of 1976, even though augmented by SWP storage releases, Sacramento River inflows were below normal due both to lack of rainfall and lower-than-average irrigation returns. As a result, Delta outflow was less than normal. By the beginning of October, salinities in the Delta were steadily increasing. Therefore, the State Water Project reduced its diversions, and from October 11 through December 31, SWP withdrawals totalled 236 million cubic metres (191,000 acre-feet).

SWP Effects on Delta Outflow

The State Water Project's operations in the Feather River, and its Delta withdrawals, are conducted in close coordin-

ation with a series of Delta water-quality objectives. The objectives are defined in terms of salinity limits at stations throughout the network of Delta waterways, as described in Chapter IV. SWP operations, through their influence on Delta flow distributions and Delta outflow, contribute to the regulation of salinity at the water-quality control stations.

The effect of SWP operations on Delta outflow at any time is estimated by subtracting the Project's net Delta withdrawals from the effect of SWP reservoir operations on Delta inflow. Project effects during 1976 are shown on Figure 12 in terms of weekly average flow rates.

In 1976, the SWP augmented Delta inflows by 945 million cubic metres (776,000 acre-feet), but withdrew a net of 1 819 million cubic metres (1,474,000 acre-feet) from the Delta. Thus the Project lowered total Delta outflow for the year by 873 million cubic metres (708,000 acre-feet). The Delta outflow index totalled 4 761 million cubic metres (3,860,000 acre-feet) in 1976, so the SWP reduced outflow during 1976 by about 15 percent. As shown on Figure 12, however, these effects varied markedly during the year, with alternating periods of outflow augmentation and reduction.

From January 1 through March 28, 1976, the SWP was storing water in its Feather River facilities while withdrawing water from the Delta at relatively high rates. During these three months, the Project reduced Delta outflows by 1 085 million cubic metres (880,000 acre-feet). However, it can be noted on Figure 10, that Delta outflow remained generally high during this period.

During the next several months, SWP operations were conducted so as to augment Delta outflows for salinity control purposes and for the protection of young striped bass. From March 29 through August 15, the Project increased outflow by a total of 395 million cubic metres (320,000 acre-feet). The average rate of the SWP outflow augmentations during these 4-1/2 months was 33 cubic metres

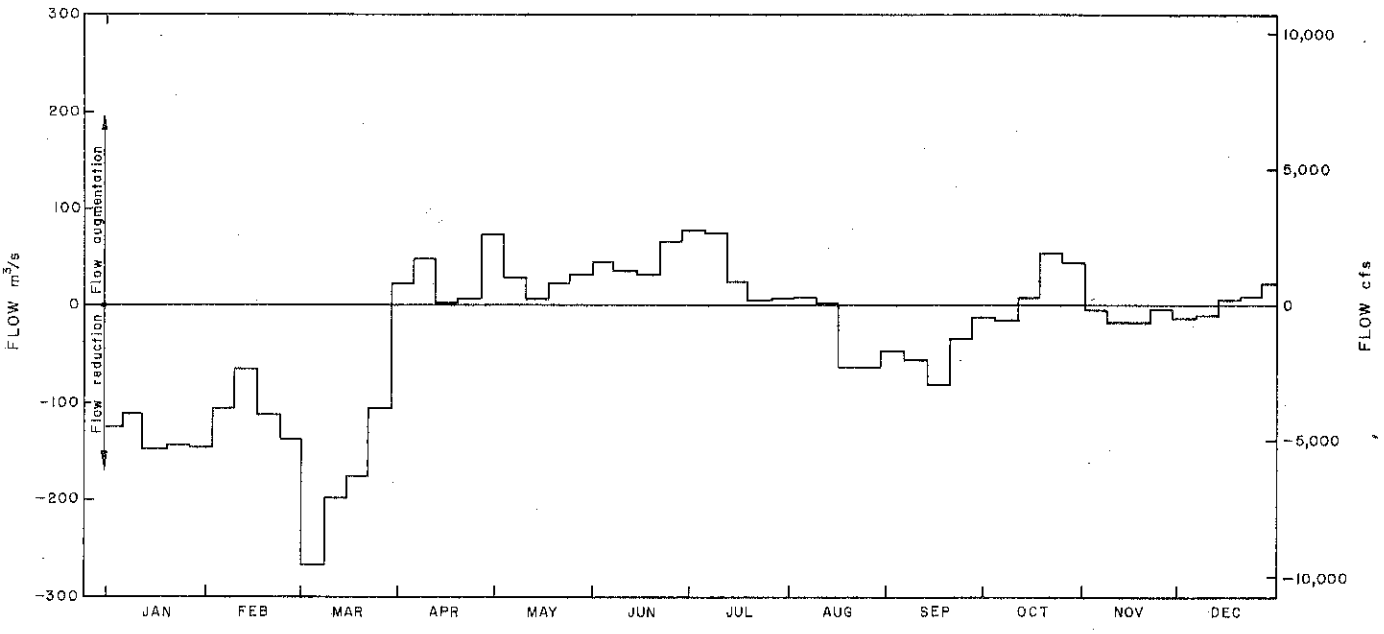


FIGURE 12

SWP EFFECTS ON DELTA OUTFLOW, 1976

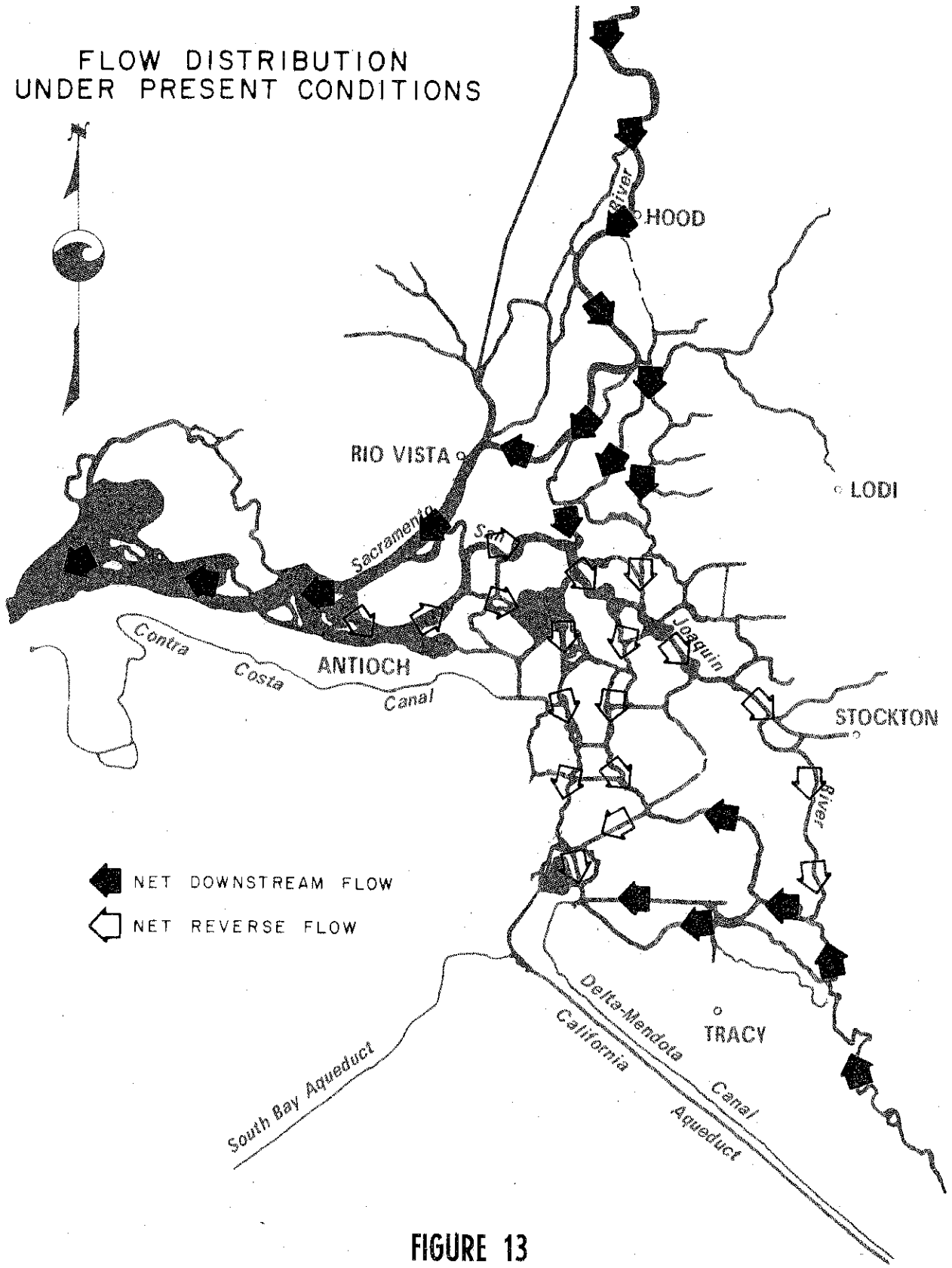


FIGURE 13

TYPICAL SUMMER FLOW DISTRIBUTION IN DELTA

(1,153 cubic feet) per second. The augmentations comprised about 23 percent of the estimated outflow for the period, and maintained a relatively constant outflow rate.

In mid-August, Delta withdrawals by the SWP were increased following completion of repairs to the California Aqueduct.. For the eight-week period from August 16 through October 10, the Project reduced Delta outflow by 224 million cubic metres (181,000 acre-feet). The average reduction in the rate of outflow was 46 cubic metres (1,632 cubic feet) per second. From October 11 through the end of the year, SWP effects on outflow were relatively small, with a net augmentation for the period of 40 million cubic metres (33,000 acre-feet).

Delta Flow Distribution

The Delta channel network comprises more than 1 100 kilometres (700 miles) of interconnected waterways. The waters are influenced by tides, and water levels throughout the region rise and fall continuously. Tides also cause flow rates in the channels to change constantly and, except during periods of higher flow, the direction of flow in most channels reverses four times during each tidal cycle of 24.8 hours. At any station, the combined effect of these changing flows is called the mean tidal cycle flow or, more simply, the net flow. flow in the "natural" direction, toward San Francisco Bay, is called "net downstream flow", and flow away from the Bay is called "net reverse flow". In addition to tidal action, the major factors that determine net flows in the various channels include tributary inflows and rates of water withdrawal by the State Water Project, the Federal Central Valley Project, and Delta water users.

During periods of higher tributary inflow, net downstream flow may become established throughout the Delta. As inflows decrease, especially the San Joaquin River inflow to the southern Delta, net reverse flow occurs in some channels. A typical summer net-flow distribution is illustrated on Figure 13. The distribution shown is characteristic of conditions that existed during most of the dry 1976 year.

The northern portion of the Delta is fed by the largest Delta tributary, the Sacramento River, and net downstream flow is typically established in all channels. A portion of the Sacramento inflow passes to the west through Sutter and Steamboat Sloughs, rejoining the main stem of the River near Rio Vista. Farther downstream, near Walnut Grove, additional Sacramento inflow is diverted into the center of the Delta through the FCVP's Delta Cross Channel and Georgiana Slough. These latter flows reach the San Joaquin River via the Mokelumne River system.

In the southern half of the Delta, which has small tributary inflows during the summer, net reverse flow is typical of most channels, except those in the extreme southeast. The major factor in establishing this flow pattern is withdrawal of water by the SWP and FCVP, although withdrawals by Delta water users are also significant.

Two features of this flow distribution are of special interest. First, Figure 13 shows net reverse flows beginning in the lower reaches of the San Joaquin River, near Antioch, and extending to the east and south. During periods of lower Delta outflow, ocean salinity intrudes into the lower San Joaquin. Reverse flow carries the saltier water inland, toward the diversion points of Delta water users as well as those of the SWP and FCVP.

Net flow reversals on the San Joaquin River side of the Delta are also of concern from the standpoint of migratory fish, which may depend on the ability to sense flow direction to reach their spawning areas. One particularly acute and recurring aspect of the fish-migration problem is related to flows in the San Joaquin River in the vicinity of Stockton. The progress of the fall sal-

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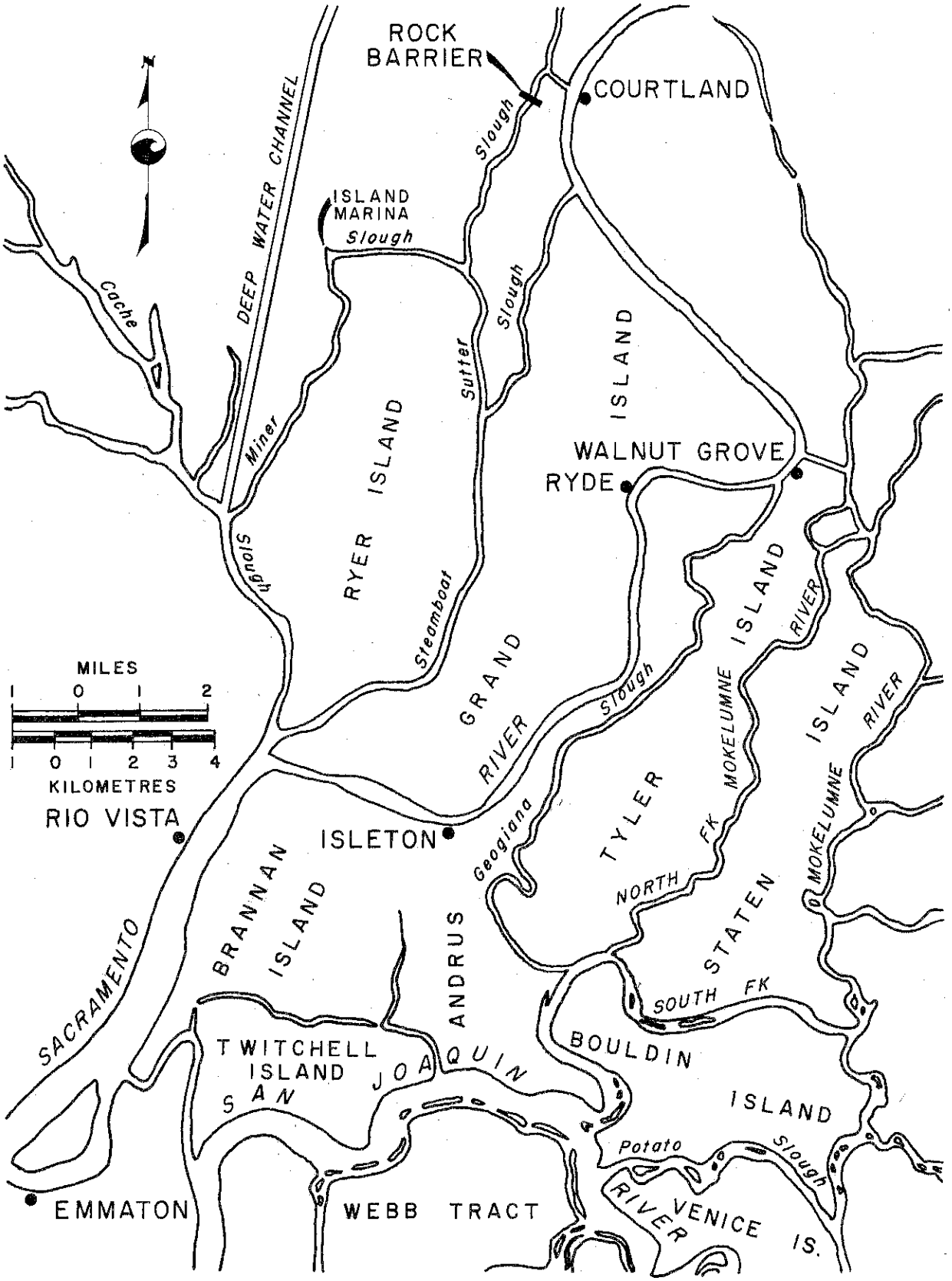


FIGURE 14
SUTTER SLOUGH CLOSURE

mon migration is frequently impeded near Stockton by a severe dissolved oxygen depression in the San Joaquin River. A number of factors apparently contribute to this situation, including the Stockton sewage discharge, the quality of inflowing waters from the San Joaquin Valley, sluggish hydraulic conditions in the Stockton Deep Water Channel, and low or, as illustrated on Figure 13, reverse flows in the area.

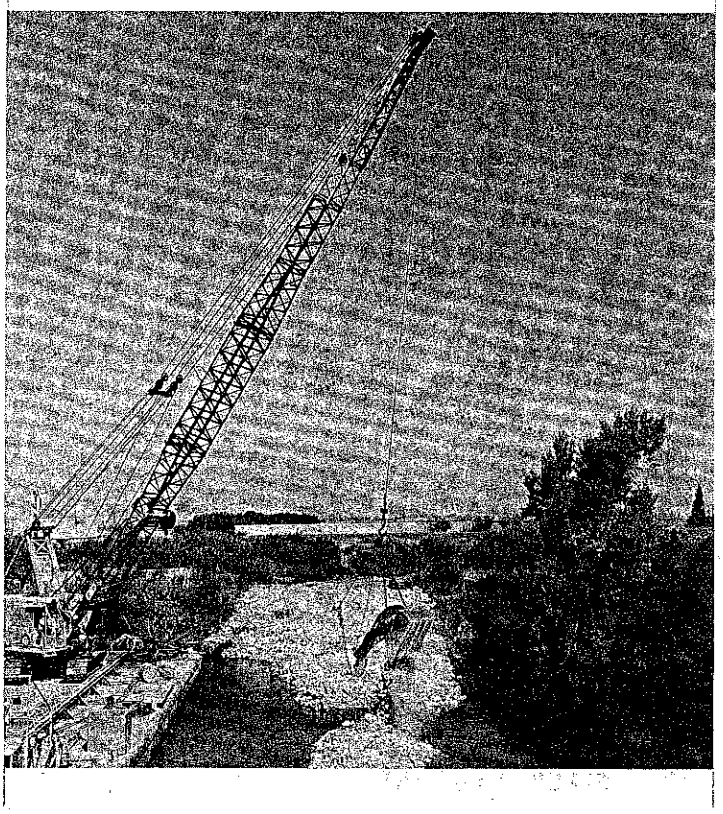
These two problems related to flow distributions, increasing salinities and impaired salmon migrations, were the focus of temporary special Delta operations by the State Water Project during 1976, as described in the following sections.

Special SWP Delta Operations - Closure of Sutter Slough

Under the sustained low Delta outflow conditions of 1976, ocean salinity intruded well into the western Delta. The State Water Project's Delta withdrawals, together with those of the Federal Central Valley Project, were contributing to flow reversals in the San Joaquin River, drawing salt water into the southern Delta.

In an effort to reduce San Joaquin River flow reversals in the western Delta, the SWP constructed a temporary closure on Sutter Slough, west of the Sacramento River, as shown on Figure 14. By restricting flow through the slough, the closure increased flow in the main channel of the Sacramento River so that greater quantities of water could be transferred to the San Joaquin River via the Delta Cross Channel and Georgiana Slough. The closure was installed on September 1, 1976, and removed on December 3.

Construction was preceded by a public hearing to inform local agricultural interests of the purposes of the project. An agreement was signed with the North Delta Water Agency, which included guarantees to safeguard water quantity and quality in the area near the closure site. A copy of the agreement is included as Addendum 3 to this report.



Sutter Slough Closure
Under Construction

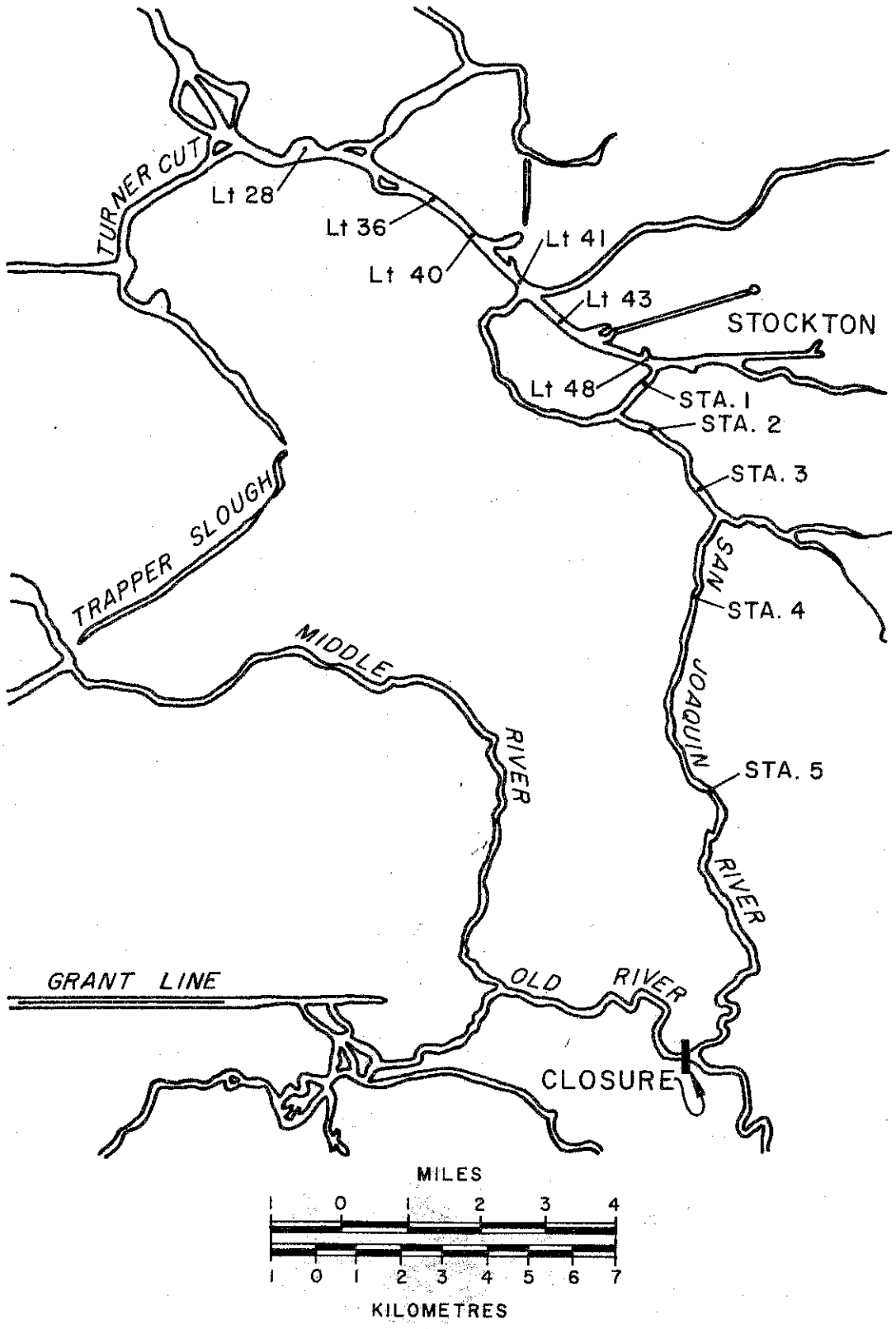


FIGURE 15
OLD RIVER CLOSURE

Because of the potential for adverse effects on local irrigation pumps and siphons, the Department of Water Resources installed or stockpiled auxiliary pumping equipment at key locations, ready for emergency use. Water quality and tide levels in the area were monitored before, during and after the period the closure was in place. The closure appeared to have little effect on salinity concentrations upstream of Rio Vista. Electrical conductivity north of the confluence of the Sacramento River and Cache Slough remained below 250 microsiemens/cm (about 165 mg/l of total dissolved solids). Biological water-quality measurements on the Sacramento River at Greene's Landing, Rio Vista, and Emmaton showed no significant changes while the closure was in place. Low tide levels immediately downstream of the closure were lowered by up to 0.30 metres (1.6 feet), but the facilities of local irrigators remained in normal service and operation of the standby pumping equipment was not required.

Since the closure increased the transfer of Sacramento River water into the Central portion of the Delta, it had the potential to interfere with the downstream migration of juvenile salmon. To assess this impact, special releases of marked salmon were made during the closure period, then sampled by trawling in the vicinity of Chipps Island. The test fish were raised at the Coleman National Fish Hatchery in the northern Sacramento Valley from eggs obtained at Keswick Dam in February, 1976. The fish were released at five Delta sites in mid-October, 1976. Analysis of the recapture rates of fish released in the Central Delta showed significantly lower recaptures than for those released in the Sacramento River system below the Delta Cross Channel and Georgiana Slough. These results suggest adverse effects on Sacramento River salmon subjected to a migration route through the Central Delta

Salinity intrusion in the Western Delta began to increase rapidly in October, 1976, and the barrier was breached. By late November, chloride concentrations at Emmaton on the Sacramento River were approaching maximum limits specified in SWP water rights permits, and it was necessary to discontinue rerouting of Sacramento River flow by the Sutter Slough closure. The facility was removed on December 3. The Department of Water Resources estimates that during its three-month life, the closure provided protection of Western Delta water quality by reducing net flow reversals in the lower San Joaquin River, and permitted the conservation of 74 million cubic metres (60,000 acre-feet) of water.

Special SWP Delta Operations - Closure of Old River

To protect the fall salmon run on the San Joaquin River, the State Water Project constructs a temporary closure on Old River, in the southeastern corner of the Delta, in years when the closure is determined to be necessary. The Old River closure, located as shown on Figure 15, is designed to direct a portion of San Joaquin River inflows to the north, toward Stockton, in an effort to flush the portion of the San Joaquin River where low dissolved oxygen concentrations impede the fall salmon migratioon. The decision to install the closure in 1976 was reached during the summer in consultation with the Department of Fish and Game, the U. S. Fish and Wildlife Service, and the U. S. Bureau of Reclamation.

Prior to construction, the closure was discussed with representatives of the South Delta Water Agency and Reclamation Districts 2062 and 544. These three agencies agreed to the installation, upon receiving assurances that the closure would be placed and designed so as to protect their interests. The Old River closure was installed on November 1 and removed on November 23, 1976.

Water quality surveys were conducted to measure dissolved oxygen concentrations along the salmon migratory path before,

during, and after installation of the closure. The results of these surveys are shown on Figure 16. On October 19, prior to installation, lowest dissolved oxygen concentrations were well below the desirable minimum of 5.5 mg/1. On November 4, just after the closure was installed, dissolved oxygen had risen to acceptable levels. Concentrations decreased somewhat while the closure was in place, but remained above 4.5 mg/1, higher than the preclosure values. A survey on November 30, after removal of the closure, showed dissolved oxygen concentrations above 5 mg/1.

The Department of Fish and Game reported that 4,000 salmon spawned in the San Joaquin River system in 1976, down from 4,500 spawners in 1975. These numbers are considered relatively low, and 1976 marked the fifth consecutive year of low San Joaquin salmon runs.

Coordinated Operation of SWP and FCVP

Both the State Water Project and the Federal Central Valley Project store water in their reservoirs for later release and delivery to their customers. In addition to the export of water withdrawn from their Sacramento Valley (and FCVP North Coastal) reservoir storage, each project's Delta exports may include some

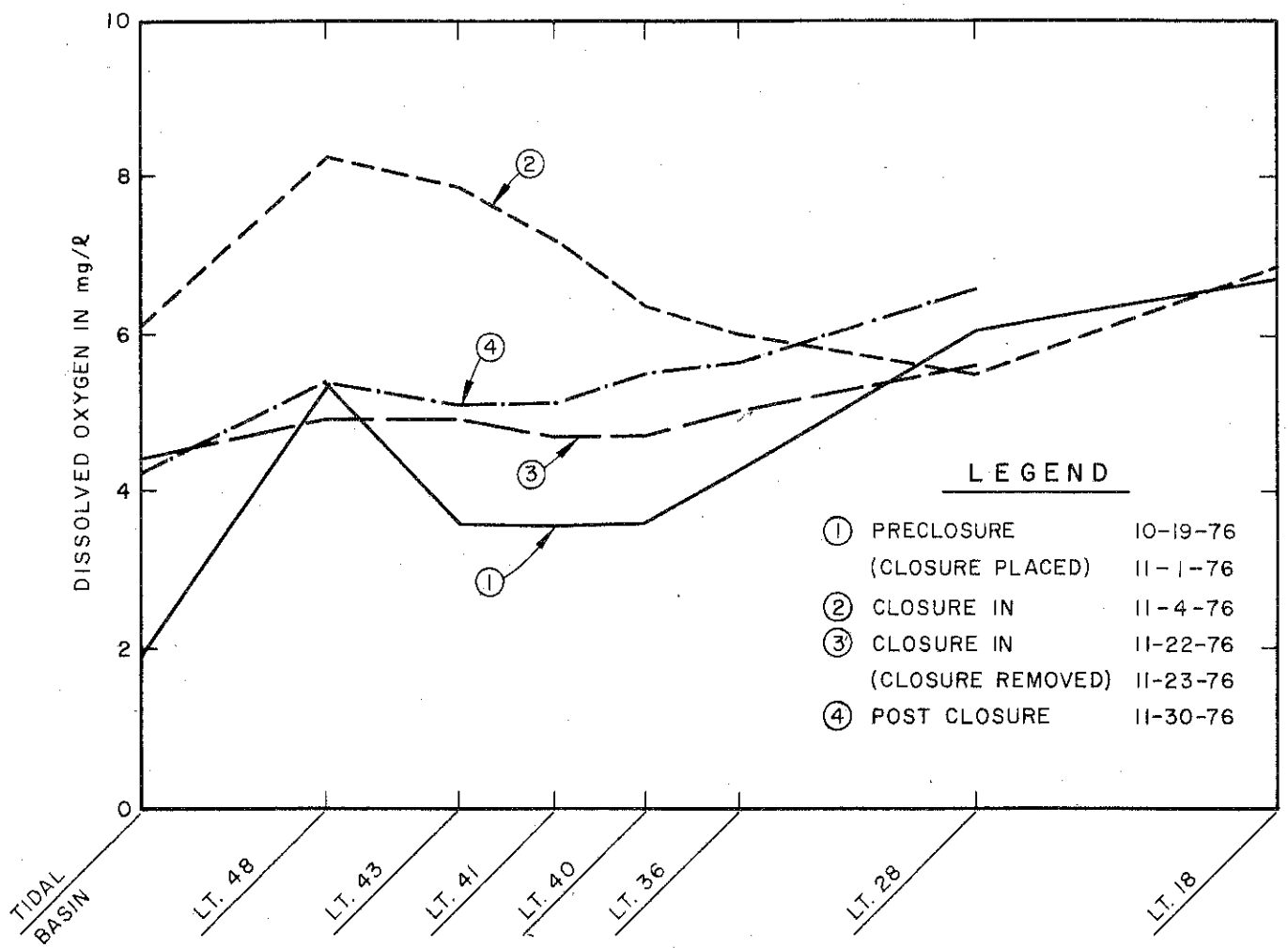


FIGURE 16

OLD RIVER CLOSURE - DISSOLVED OXYGEN CONCENTRATIONS IN SAN JOAQUIN RIVER NEAR STOCKTON

unstored water[1]. The two projects share use of the Sacramento River and the Delta as conveyance routes to their pumping facilities; the waters belonging to, or available for the use of, each project, being comingled, cannot be separately identified. In times of abundant water supply, described as "excess water conditions", the projects can be operated in a relatively independent manner. For a portion of most years, however, the total of unstored water and withdrawals from reservoir storage provides just enough water to meet the in-basin uses of the Sacramento Valley and the Delta, exports by the State and Federal projects, and sufficient Delta outflow to meet agreed-upon water-quality objectives. During such periods of "balanced water conditions", operation of the SWP and FCVP must be closely coordinated.

The need for coordinated operation has led to the development of a draft coordination agreement between the two projects. This draft, dated May 13, 1971, stipulates water-quality objectives to be met, and describes a procedure for determining how each of the projects is to be operated in times of both "excess" and "balanced" water conditions. Coordination during excess water conditions involves certain bookkeeping procedures intended to maintain a record of each project's water operations. During balanced conditions, the draft agreement describes a series of detailed computations, which allocate any exported unstored water between the projects. When unstored water is insufficient to meet the in-basin uses of the Sacramento Valley and the Delta, including Delta outflow required to maintain the water-quality objectives, the draft agreement assigns to each project a share of the shortage, which is to be met by increases in respective reservoir-storage withdrawals, reductions in Delta exports, or both. Although still a draft, the coordination agreement has been implemented by an annual letter agreement, in which the agencies agree to operate under terms of the draft.[2]

During 1976 there was a difference of opinion between the SWP and FCVP as to the water quality objectives stipulated by the agreement.

Most of 1976 was characterized by balanced water conditions (February 1 to December 31), as indicated on Chart A of the 1976 State Water Project Annual Report of Operations. The State Water Project was operated in an effort to achieve compliance with Delta salinity criteria contained in its water rights permits, and to meet water quality objectives established in the Delta and San Francisco Bay Basin Plans adopted by the State Water Resources Control Board, and approved by the Environmental Protection Agency. DWR's position is that the Basin Plan water-quality objectives automatically became a part of the coordination agreement pursuant to its Article C-1 of Exhibit A, which states: "Water-quality objectives set forth shall be modified as appropriate to comply with water-quality objectives adopted by any Federal or State regulatory agency or court which has jurisdiction".

The USBR disagreed with the automatic modification of the coordination agreement water quality objectives, on the basis that the FCVP is not subject to the Federal Water Pollution Control Act. Therefore, the FCVP water operations recognized a different, less-stringent set of salinity objectives requiring

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(1) Unstored water is all water other than FCVP-SWP reservoir storage withdrawals available for meeting Sacramento Valley and Delta uses, including Delta outflow and export from the Delta.

(2) The draft agreement was made effective for 1976 by a letter agreement dated November 24, 1975.

lower rates of Delta outflow than did the SWP.

The FCVP limited storage withdrawals for Delta outflow augmentation to the FCVP share of the lower outflows, computed according to the formulas of the coordination agreement. Also, because its estimate of the outflow requirements were lower than that of the SWP, the USBR assumed that there were greater volumes of Delta water available for FCVP export. Responsibility was therefore left to the State Water Project to provide additional storage releases, or to forego the export of unstored water to maintain the higher rates of Delta outflow required to meet the Basin Plan water quality objectives.

The SWP and FCVP differed as to their respective responsibilities for Delta outflow maintenance on 99 days during 1976. Table 2 compares the daily outflow index recognized by the FCVP with the computed index for each of the 99 days. Differences between each pair of values show additional outflow maintained by the SWP for Delta salinity control. The Federal share of the additional outflow, computed according to the coordination agreement using SWP operating criteria, represents the effect of the FCVP actions on SWP operations.

From May 26 through July 20, 1976, a period of 56 days, the FCVP recognized a minimum Delta outflow index requirement of 113 cubic metres (4,000 cubic feet) per second. During this period, ocean salinity intrusion was raising salinity at Chipps Island in the western Delta to concentrations approaching criterion intended to protect Neomysis as a striped bass food supply. (See the discussion of this criterion in Chapter IV.) The State Water Project was operated to maintain a Delta outflow index intended to control salinity intrusion at Chipps Island. The index was generally higher than that recognized by the FCVP. The additional Delta outflow during these two months was 46 million cubic metres (37,379 acre-feet), and the Federal share, using SWP criteria, was 35 million cubic metres (28,035 acre-feet). The outflow index is subject to fluctuation and cannot be precisely controlled. For that reason, the index fell below the FCVP criterion for eight days during May through July. The Federal share of additional outflow has been reduced accordingly.

For 43 days between October 8 and December 2, 1976, the FCVP recognized Delta outflow index requirements ranging from 57 cubic metres (2,000 cubic feet) per second to 71 cubic metres (2,500 cubic feet) per second. By early October, the Delta outflow index was approaching its lows for the year, and rapid salinity intrusion into the western Delta was underway. It was apparent that a number of Delta salinity criteria would be exceeded in the absence of substantial rainfall. Again, State Water Project operations were conducted so as to maintain higher Delta outflow index rates than those acknowledged by the FCVP. The additional computed outflow index during this period amounted to 140 million cubic metres (113,438 acre-feet) and the Federal share, according to SWP criteria, was 78 million cubic metres (63,373 acre-feet).

For the entire year, the Delta outflow index totalled 4 761 million cubic metres (3,860,000 acre-feet) of which SWP and FCVP shared 4 575 million cubic metres (3,709,000 acre-feet). Of the 186 million cubic metres (151,000 acre-feet) not shared by the FCVP, the Federal share under the coordination agreement, using SWP criteria, was 113 million cubic metres (91,408 acre-feet).

TABLE 2

SWP ASSUMPTION OF FEDERAL SHARE OF DELTA OUTFLOW INDEX, 1976

Date		Delta Outflow Index m^3/sec (cfs)		Additional Outflow m^3/sec (cfs)	
		CVP Policy	Computed	Total	Federal Share
May	26	113 (4,000	127 (4,485)	13.7 (485)	10.3 (364)
	27	"	126 (4,448)	12.7 (448)	9.5 (336)
	28	"	133 (4,680)	19.3 (680)	14.4 (510)
	29	"	113 (3,985)	-0.4 (-15)	-0.3 (-11)
	30	"	107 (3,769)	-6.5 (-231)	-4.9 (-173)
	31	"	109 (3,837)	-4.6 (-163)	-3.5 (-122)
June	1	"	119 (4,206)	5.8 (206)	4.4 (154)
	2	"	116 (4,111)	3.1 (111)	2.4 (83)
	3	"	120 (4,235)	6.7 (235)	5.0 (176)
	4	"	115 (4,052)	1.5 (52)	1.1 (39)
	5	"	112 (3,964)	-1.0 (-36)	-0.8 (-27)
	6	"	110 (3,901)	-2.8 (-99)	-2.1 (-74)
	7	"	116 (4,110)	3.1 (110)	2.3 (82)
	8	"	124 (4,364)	10.3 (364)	7.7 (273)
	9	"	126 (4,436)	12.3 (436)	9.3 (327)
	10	"	129 (4,565)	16.0 (565)	12.0 (424)
	11	"	128 (4,512)	14.5 (512)	10.9 (384)
	12	"	119 (4,190)	5.4 (190)	4.0 (142)
	13	"	120 (4,240)	6.8 (240)	5.1 (180)
	14	"	118 (4,157)	4.4 (157)	3.3 (118)
	15	"	121 (4,271)	7.7 (271)	5.7 (203)
	16	"	118 (4,170)	4.8 (170)	3.6 (128)
	17	"	116 (4,106)	3.0 (106)	2.3 (80)
	18	"	117 (4,147)	4.2 (147)	3.1 (110)
	19	"	107 (3,786)	-6.1 (-214)	-4.5 (-160)
	20	"	103 (3,631)	-10.4 (-369)	-7.8 (-277)
	21	"	121 (4,287)	8.1 (287)	6.1 (215)
	22	"	121 (4,272)	7.7 (272)	5.8 (204)
	23	"	122 (4,317)	9.0 (3.7)	6.7 (238)
	24	"	122 (4,326)	9.2 (326)	6.9 (244)
	25	"	122 (4,312)	8.8 (312)	6.6 (234)
	26	"	119 (4,216)	6.1 (216)	4.6 (162)
	27	"	118 (4,166)	4.7 (166)	3.5 (124)
	28	"	118 (4,170)	4.8 (170)	3.6 (128)
	29	"	120 (4,221)	6.3 (221)	4.7 (166)
	30	"	117 (4,148)	4.2 (148)	3.1 (111)

TABLE 2
(Continued)

SWP ASSUMPTION OF FEDERAL SHARE OF DELTA OUTFLOW INDEX, 1976

Date		Delta Outflow Index m^3/sec (cfs)		Additional Outflow m^3/sec (cfs)	
		CVP Policy	Computed	Total	Federal Share
July	1	113 (4,000)	111 (3,931)	-2.0 (-69)	-1.9 (-52)
	2	"	125 (4,417)	11.8 (417)	8.9 (313)
	3	"	117 (4,141)	4.0 (141)	3.0 (106)
	4	"	124 (4,392)	11.1 (392)	8.3 (294)
	5	"	116 (4,080)	2.3 (80)	1.7 (60)
	6	"	147 (5,202)	34.0 (1,202)	25.5 (902)
	7	"	147 (5,180)	33.4 (1,180)	25.1 (885)
	8	"	149 (5,246)	35.3 (1,246)	26.4 (934)
	9	"	147 (5,191)	33.7 (1,191)	25.3 (893)
	10	"	148 (5,215)	34.4 (1,215)	25.8 (911)
	11	"	150 (5,298)	36.8 (1,298)	27.6 (974)
	12	"	148 (5,232)	34.9 (1,232)	26.2 (924)
	13	"	135 (4,762)	21.6 (762)	16.2 (572)
	14	"	128 (4,526)	14.9 (526)	11.2 (394)
	15	"	125 (4,402)	11.4 (402)	8.6 (302)
	16	"	117 (4,119)	3.4 (119)	2.5 (89)
	17	"	115 (4,068)	1.9 (68)	1.4 (51)
	18	"	115 (4,059)	1.7 (59)	1.2 (44)
	19	"	121 (4,257)	7.3 (257)	5.5 (193)
	20	"	123 (4,334)	9.5 (334)	7.1 (250)
October	8	62 (2,200)	65 (2,301)	2.9 (101)	1.4 (48)
	9	62 (2,200)	72 (2,536)	9.5 (336)	4.6 (161)
	10	62 (2,200)	70 (2,475)	7.8 (275)	3.7 (132)
	11	62 (2,200)	64 (2,251)	1.4 (51)	1.1 (38)
	16	57 (2,000)	71 (2,507)	14.4 (507)	10.8 (380)
	18	"	71 (2,503)	14.2 (503)	10.7 (377)
	19	"	101 (3,568)	44.4 (1,568)	33.3 (1,176)
	20	"	101 (3,584)	44.9 (1,584)	33.6 (1,188)
	21	"	99 (3,498)	42.4 (1,498)	31.8 (1,124)
	22	"	105 (3,701)	48.2 (1,701)	36.1 (1,276)
	23	"	107 (3,778)	50.3 (1,778)	37.8 (1,334)
	24	"	106 (3,745)	49.4 (1,745)	37.1 (1,309)
	25	"	104 (3,664)	47.1 (1,664)	35.3 (1,248)

TABLE 2
(Continued)

SWP ASSUMPTION OF FEDERAL SHARE OF DELTA OUTFLOW INDEX, 1976

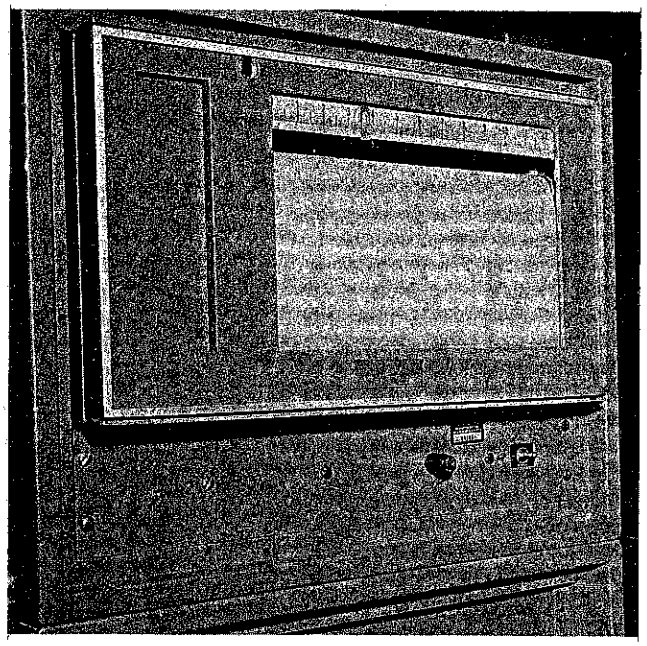
Date		Delta Outflow Index m^3/sec (cfs)		Additional Outflow m^3/sec (cfs)	
		CVP Policy	Computed	Total	Federal Share
October	26	57 (2,000)	101 (3,567)	44.4 (1,567)	33.3 (1,175)
	27	"	101 (3,575)	44.6 (1,575)	32.1 (1,133)
	28	"	102 (3,595)	45.2 (1,595)	33.9 (1,196)
	29	"	100 (3,547)	43.8 (1,547)	32.8 (1,160)
	30	"	100 (3,522)	43.1 (1,522)	32.3 (1,142)
	31	"	104 (3,661)	47.0 (1,657)	35.2 (1,243)
November	1	"	85 (3,017)	28.8 (1,017)	21.6 (763)
	10	71 (2,500)	85 (2,966)	14.0 (496)	6.2 (218)
	11	"	88 (3,107)	17.2 (607)	7.6 (267)
	12	"	104 (3,658)	32.8 (1,158)	14.4 (510)
	13	"	102 (3,607)	31.3 (1,107)	13.8 (487)
	14	"	106 (3,734)	34.9 (1,234)	15.4 (543)
	15	"	98 (3,474)	27.6 (974)	12.1 (429)
	16	"	106 (3,740)	35.1 (1,240)	15.5 (546)
	17	"	98 (3,457)	27.1 (957)	11.9 (421)
	18	"	102 (3,612)	31.5 (1,112)	13.8 (489)
	19	"	115 (4,055)	44.0 (1,555)	19.4 (684)
	20	"	115 (4,049)	43.9 (1,549)	19.3 (682)
	21	"	115 (4,053)	44.0 (1,553)	19.3 (683)
	22	"	134 (4,731)	63.2 (2,231)	27.8 (982)
	23	"	156 (5,511)	85.3 (3,011)	37.5 (1,325)
	24	"	113 (4,008)	42.7 (1,508)	18.8 (664)
	25	"	115 (4,047)	43.8 (1,547)	19.3 (681)
	26	"	115 (4,066)	44.3 (1,566)	19.5 (689)
	27	"	115 (4,061)	44.2 (1,561)	19.5 (687)
	28	"	114 (4,037)	43.5 (1,537)	19.1 (676)
	29	"	99 (3,500)	28.3 (1,000)	12.5 (440)
	30	"	113 (4,000)	42.5 (1,500)	18.7 (660)
December	1	"	124 (4,376)	53.1 (1,876)	19.1 (676)
	2	"	142 (5,021)	71.4 (2,521)	25.7 (908)

IV. DELTA SALINITY

The waters of the Sacramento-San Joaquin Delta are a source of agricultural, municipal and industrial water supply utilized both within and beyond the Delta. Among other uses, the area's rivers and sloughs provide habitat for a variety of fish and wildlife and are an intensively used recreational resource. The suitability of the Delta for these uses depends substantially on the salinity of its waters.

Salinity in the Delta varies in response to: changes in the rate and salinity of tributary inflows; the quantity and salinity of local waste discharges (especially agricultural return flows); the distribution of flows in the Delta channel network; and Delta outflow. Delta outflow acts against salinity intrusion driven by tidal forces through San Francisco Bay. Except for the local waste discharges and tidal forces, each of these determining factors is subject to direct modification by in-basin water uses and by Central Valley water resources development projects in general, including the operations of the State Water Project discussed in Chapter III.

State Water Project operations are designed to achieve compliance with a set of criteria expressed in terms of maximum salinity limitations for the protection of beneficial use at stations throughout the Delta as shown on Figure 17. The criteria in effect during 1976 were (1) the "Delta Water Quality Objectives" stated in the State Water Resources Control Board's Basin 5B Plan for the Delta, (2) salinity objectives in the Basin 2 Plan for San Francisco Bay, and (3) requirements contained in SWP's water rights permits under the Board's Water Rights Decisions 1275 and 1291. The Project is also operated to meet water quality objectives applied to its Delta withdrawals and stated in water service contracts with SWP customers.



Continuous Salinity Recorder Used to Measure Compliance with Delta Water Quality Objectives

During 1976, several Delta salinity objectives at locations susceptible to control through State Water Project operation were achieved. However, several were not met, especially during the final weeks of the year as drought conditions in the Central Valley persisted. SWP operations contributed to the achievement of some objectives and nonachievement of others. This chapter describes the criteria in effect during the year, which are related to Project operation and compares then with observed salinities. Cases where salinity limits were exceeded are discussed in terms of SWP operations. Detailed salinity data relating to these discussions are included as Addendum 4 to this report.

In considering the information that follows, it is important to recognize that the underlying cause for failure to fully achieve all Delta salinity objectives during the year was the scarcity of water in the Central Valley. Delta

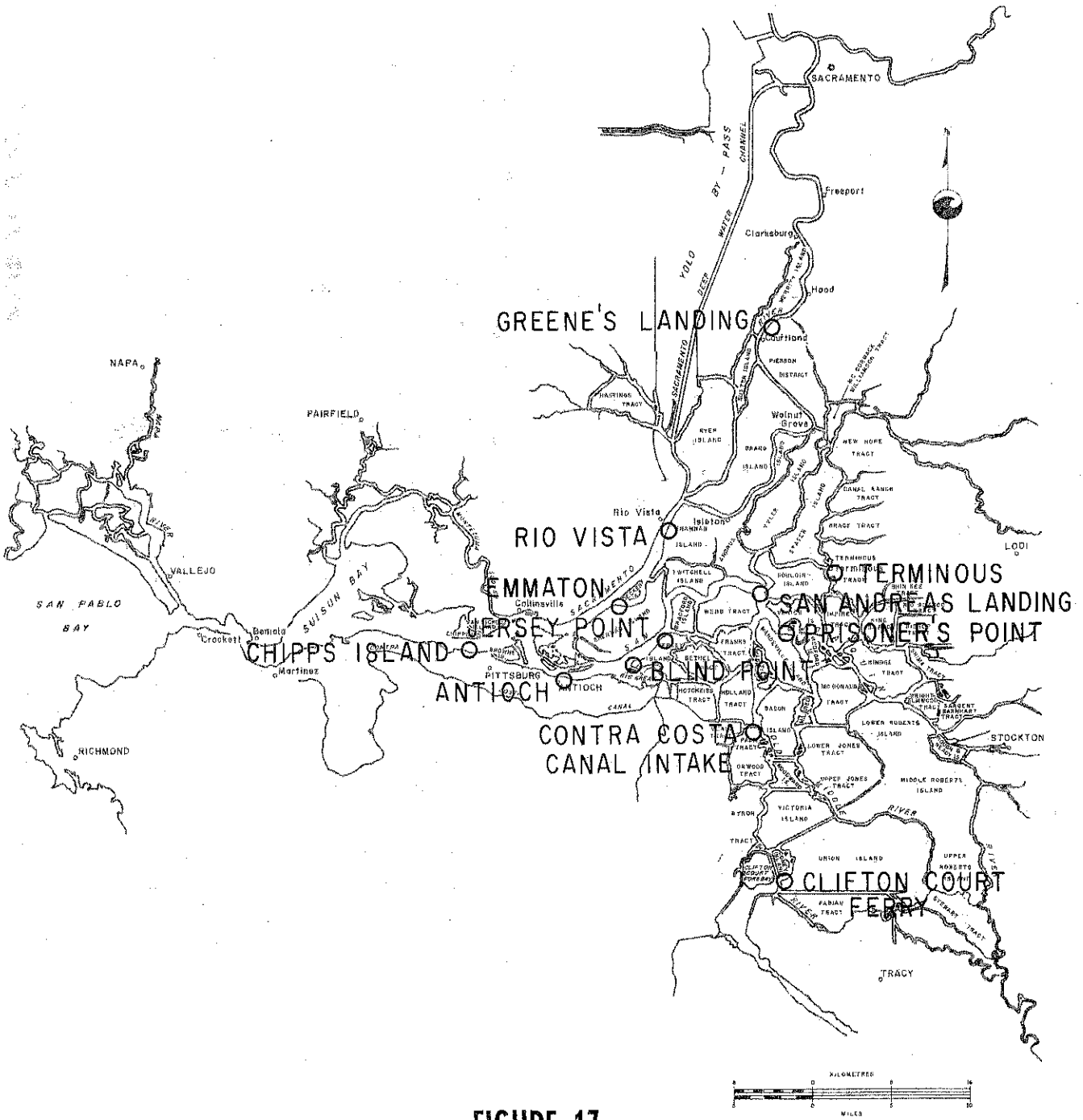


FIGURE 17

SALINITY CONTROL STATIONS

salinity varied in response to the limitations imposed by the drought on: SWP operations; the activities of numerous other Central Valley water resources projects; and in-basin water demands. Therefore, the picture presented in this report is necessarily incomplete, since only water operations of the SWP are discussed.

Criteria for Protection of Interior Delta Agriculture

The Basin 5B Plan specifies maximum limitations on total dissolved solids concentrations at four interior Delta stations: Little Potato Slough at Terminous, Sacramento River at Rio Vista, San Joaquin River at San Andreas Landing, and Old River at Clifton Court Ferry. The objectives, designed to assure water quality suitable for farming in the Delta, not only include maximum annual average salinity limits, but also provide for short-term variations through limitations on both the 14-day average salinity and monthly average salinity at the four stations. In dry years such as 1976, the limits are relaxed after April 1. The limits are also subject to upward adjustment whenever the TDS concentration of the Sacramento River at Greene's Landing exceeds 150 mg/1. During 1976, however, the maximum TDS observed at Greene's Landing was 135 mg/1, and no adjustment was applied on that basis.

Table 3 presents the criteria in effect during 1976 and compares them with salinities observed at the four stations. As shown on Table 3, the objectives were achieved, since observed salinities were well below the limits at all stations. The closest approach to any limit was the monthly average TDS at Rio Vista, which reached 510 mg/1 during December, compared with the limitation of 600 mg/1. Rio Vista, the westernmost of the four stations, was influenced by ocean salinity intrusion late in the year, as the low Delta outflows associated with the 1976 drought persisted through the year's end.

Criteria for Protection of Western Delta Agriculture

1. Emmaton and Jersey Point

SWRCB Decisions 1275 and 1291 require that in a non-critical year, as defined by total inflow to Shasta Reservoir, the running 10-day average of mean daily chloride concentrations at Emmaton on the Sacramento River and Jersey Point on the San Joaquin River shall not exceed 1 000 mg/1. The Basin 5B Plan objective for these stations is also a limit of 1 000 mg/1, but is based upon 14-day averages.

At Jersey Point, the objective was achieved throughout 1976. Ten-day average concentrations ranged from 8 mg/1 on January 1 to a maximum of 662 mg/1 on December 24. (The range for the 14-day average was from 8 mg/1 on January 1 to 659 mg/1 on December 19.)

At Emmaton, the chloride objectives were achieved through the first eleven months of the year. On December 6, however, the 10-day mean daily chloride concentration rose above 1 000 mg/1, reaching a maximum of 1 321 mg/1 on December 21. (The 14-day average exceeded 1 000 mg/1 beginning on December 7, and peaked at 1 323 mg/1 on December 20.) Both the 10-day and 14-day means remained above 1 000 mg/1 through the end of December.

Figure 18 shows 10-day average chloride concentrations at Emmaton for the last three months of 1976, compared with the operation of the State Water Project in terms of its effect on Delta outflow. During the period in November when the salinity limit was being approached, the SWP was decreasing outflow. At about the time the limit was exceeded, SWP operations were adjusted to provide some augmentation of Delta outflow. Although increased flows were provided through the end of the year, achievement of the objective was not restored.

The chloride data in Figure 18 illustrate the necessity for having breached the

TABLE 3

SALINITIES AT FOUR INTERIOR DELTA STATIONS - 1976
(Total Dissolved Solids in mg/l)

	Maximum 14-day Mean		Maximum Monthly Mean		Mean	
	Jan-Mar	Apr-Dec	Jan-Mar	Apr-Dec	Jan-Mar	Apr-Dec
Dry Year Objective at Each Station	700	800	500	600	450	500
Observed Salinities:						
Little Potato Slough at Terminous	132 (Feb 7)	172 (Sep 26)	126 (Mar)	167 (Sep)	123	133
Sacramento River at Rio Vista	137 (Mar 30)	559 (Dec 25)	125 (Mar)	510 (Dec)	120	236
San Joaquin River at San Andreas Landing	135 (Mar 31)	247 (Sep 27)	125 (Mar)	232 (Dec)	117	178
Old River at Clifton Court Ferry	223 (Feb 25)	476 (Dec 31)	204 (Feb)	433 (Dec)	184	279
Dry Year Objective - Average of All Stations		700		500		450
Observed Salinities - Average of All Stations		345 (Dec 30)		324 (Dec)		207

Sutter Slough Closure in early October, as discussed in Chapter III. Recall that the closure reduced flow reversals in the San Joaquin River by increasing the transfer of Sacramento River flows through the Central Delta. This benefit was achieved at the expense of reducing downstream Sacramento River flow in the Western Delta, with a corresponding increase in the rate of ocean salinity intrusion toward Emmaton. Removal of the closure was required as chloride concentrations at Emmaton approached the maximum limits stated in SWP water rights permits.

2. Blind Point

SWP water rights permits under SWRCB Decision 1275 and 1291 include an operational restriction during April, May, and June for the protection of agricultural water uses in the Western Delta. During those months, if the maximum daily chloride concentration exceeds 250 mg/l at Blind Point, on the San

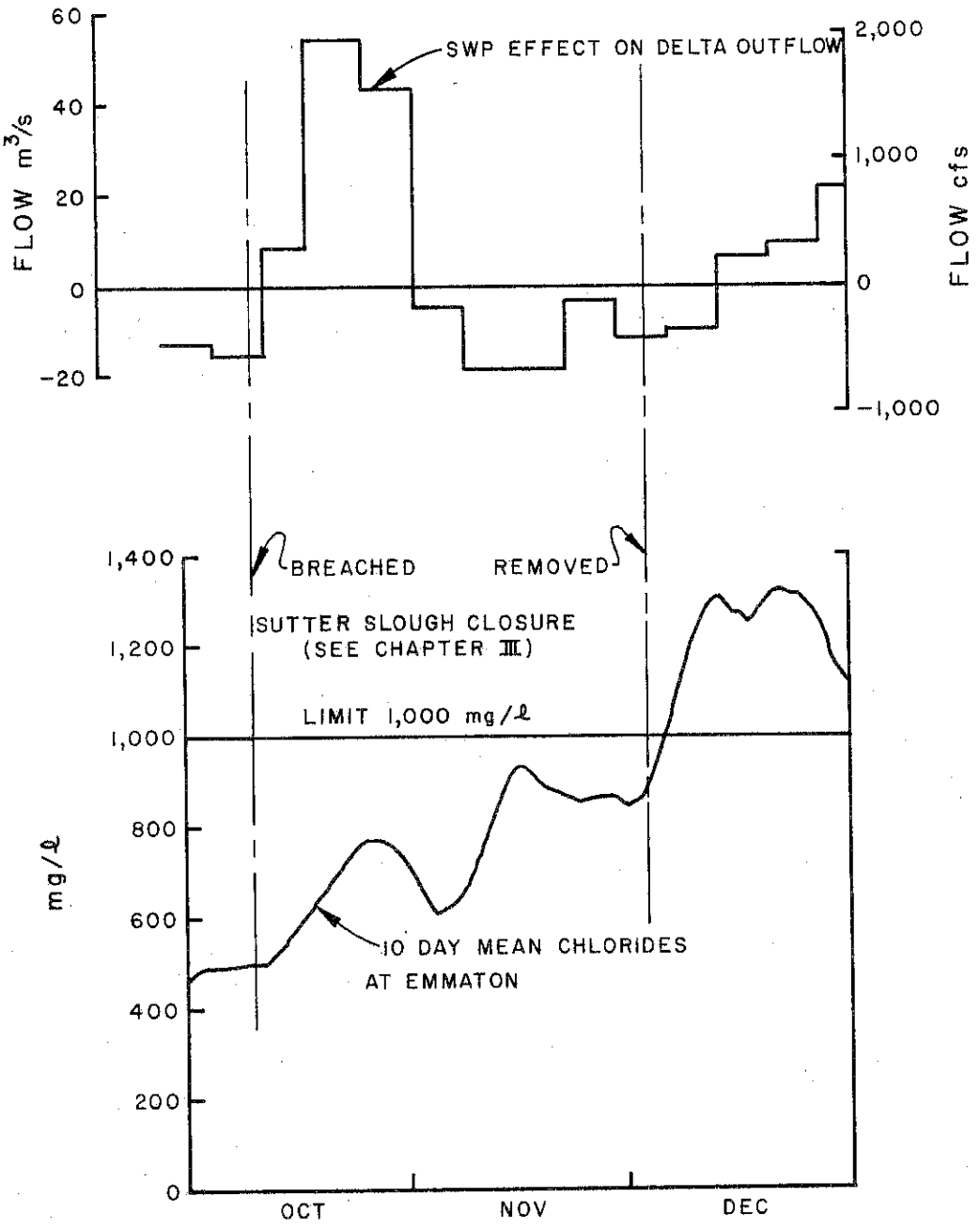


FIGURE 18

CHLORIDE CONCENTRATIONS AT EMMATON

Joaquin River, the Project may not increase storage in its reservoirs. Further, the Project may not make direct diversions from the Delta. That is, if the Project withdraws water from the Delta, it must release from reservoir storage at least the amount of water withdrawn plus the amount of natural inflow to the reservoirs.

Figure 19 presents maximum daily chloride data observed at Blind Point from April 1 through June 30, 1976. Except for a total of 14 days during the latter part of April, maximum chloride concentrations exceeded 250 mg/l for the entire period. The highest chloride level observed during the period was 1 240 mg/l on June 28.

Figure 19 also presents SWP operations data showing compliance with the operational restrictions of the water rights permits. From April through June, the Project reduced reservoir storage, augmenting Sacramento River inflows to the Delta by 392 million cubic metres (318,000 acre-feet) at weekly average rates ranging from 17-89 cubic metres (591-3,142 cubic feet) per second. Further, the Project did not make direct diversions from the Delta. Delta withdrawals by the SWP were less than net storage releases throughout the period, and the project augmented Delta outflow at rates ranging from 2-84 cubic metres (67-2,956 cubic feet) per second. The total outflow augmentation was 292 million cubic metres (237,000 acre-feet).

For the further protection of Western Delta agriculture, the Basin 5B Plan establishes objectives limiting electrical conductivity at Blind Point, on the San Joaquin River, as follows: in a "non-critical" year, the 14-day mean EC is limited to maximums of 2 200 microsiemens/cm from April through July, and 3 100 microsiemens/cm from August through December.

The objective was achieved for the April-July period, when the 14-day mean EC ranged from 528 microsiemens/cm in late April to 1 991 microsiemens/cm in mid-July. The 3 100 microsiemens/cm limit was also maintained from August through early December. Beginning December 11, however, the 14-day EC rose above 3 100 microsiemens/cm and remained above that level for the remainder of the year, reaching a maximum of 3 339 microsiemens/cm on December 20.

Blind Point electrical conductivity for October through December, 1976, is shown on Figure 20 in comparison with State Water Project effects on Delta outflow. During November, as the limit was being approached, SWP operations were resulting in reductions in outflow. Shortly after the limit was exceeded in December, however, Project operations were modified to augment Delta outflow.

Criterion for Protection of Delta Agriculture - Spring Flushing

To provide Delta farms with high-quality water at the beginning of the irrigation season, SWRCB Decisions 1275 and 1291 require that the mean daily chloride concentration at Emmaton and Jersey Point shall not exceed 200 mg/l for at least 10 consecutive days between April 1 and May 31, except in dry or critical years. This criterion is also included in the Basin 5B Plan. Since 1976 was a dry year according to the Shasta inflow definition, the criterion was not applicable. However, the criterion was met. At Jersey Point, mean daily chlorides were less than 200 mg/l from April 1 through May 13, and at Emmaton chlorides were below the limit from April through May 12.

Criteria for Protection of Contra Costa Canal Water Quality

The Basin 5B Plan specifies limits on the concentrations of both chlorides and total dissolved solids at the Contra Costa Canal intake at Rock Slough, near Old River in the southern Delta. Mean tidal cycle chlorides are not to exceed 250 mg/l, with a further limit of 100 mg/l during 65 percent of any water year

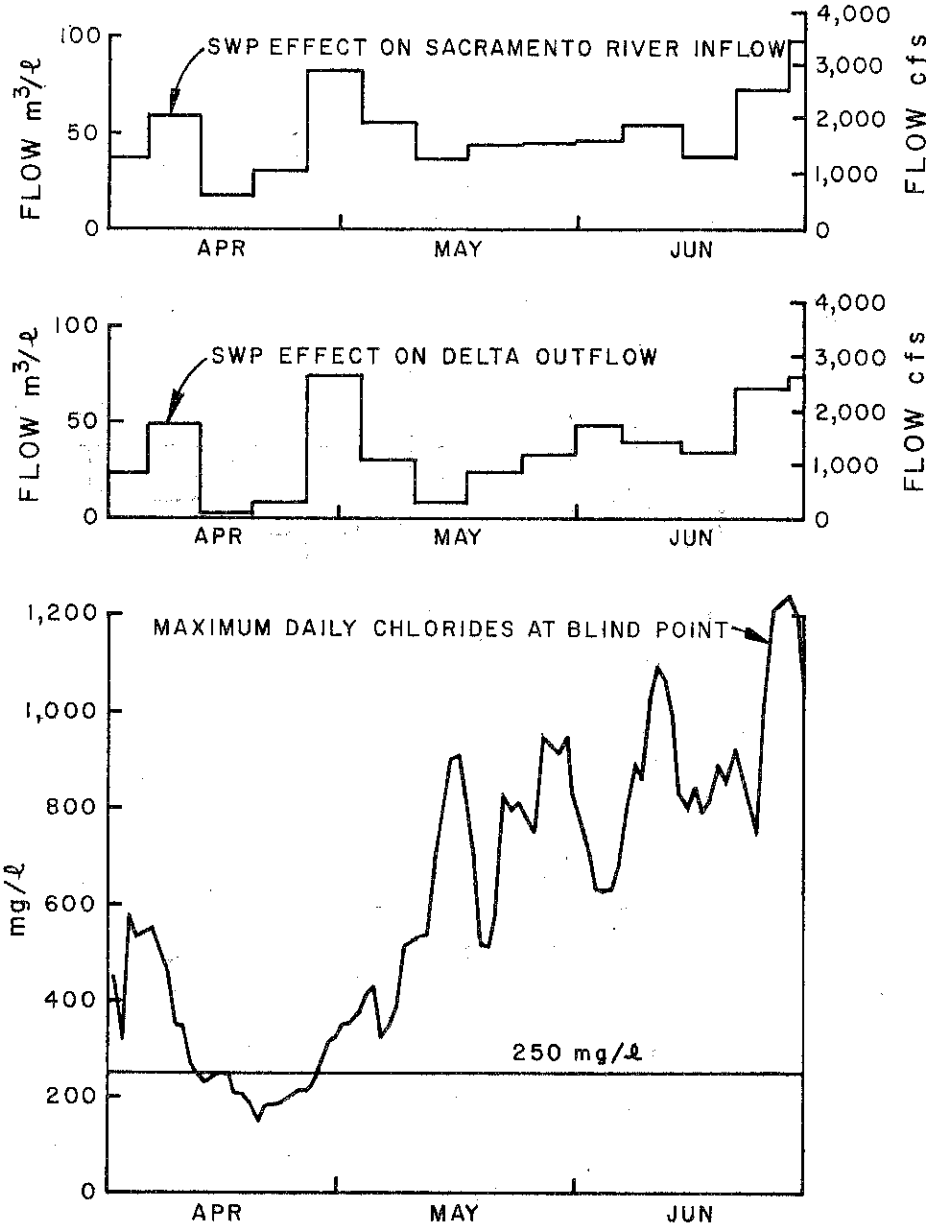


FIGURE 19

CHLORIDE CONCENTRATIONS AT BLIND POINT

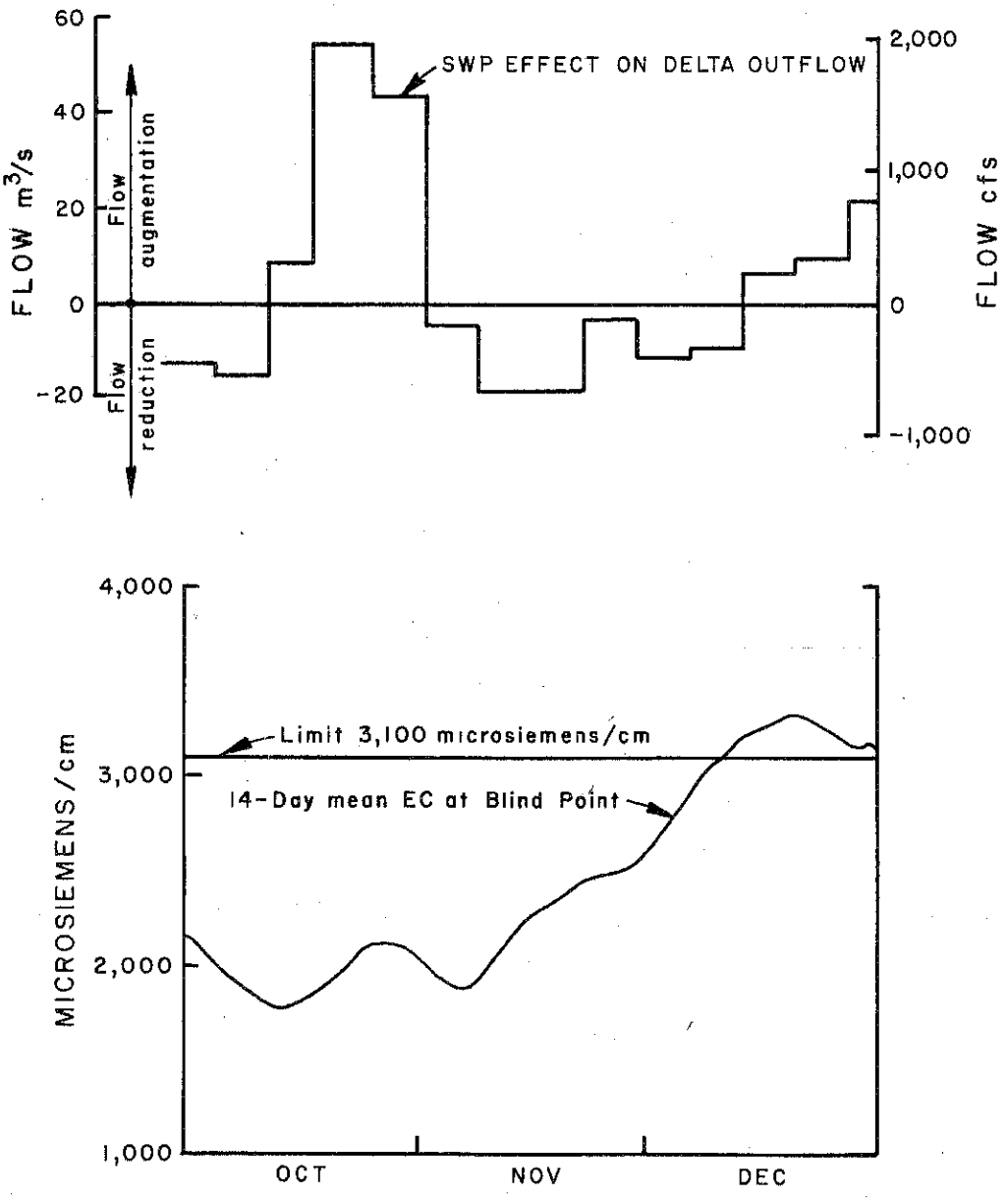


FIGURE 20

ELECTRICAL CONDUCTIVITY AT BLIND POINT

(October 1 through September 30 of the following calendar year). For total dissolved solids, the maximum concentration is 750 mg/1, and the concentration is limited to 380 mg/1 for 65 percent of any water year.

These dual objectives reflect the fact that the Canal's water supply is vulnerable to salinity from two distinct sources. Higher chloride concentrations at the Canal intake usually occur during the summer. They are nearly always the result of ocean salinity intrusion caused by (1) relatively low Delta outflows combined with (2) flow reversals extending from the western Delta toward the Canal intake. Total dissolved solids levels rise with increasing ocean intrusion as well. However, TDS also tends to rise during the winter months due to relatively large agricultural drainage discharges from leaching operations on local farmlands. From the standpoint of water project operations, it is interesting to note that summer chloride concentrations at the Canal intake are subject to some control through reductions in Delta exports by the SWP and FCVP. This is because these exports affect western Delta flow reversals. Diversions into the Contra Costa Canal, a unit of the FCVP, contribute to this effect. On the other hand, winter TDS levels may be lowered by increased export, which draws fresher Sacramento River flows across the Delta past the Canal intake. Of course, portions of the saltier agricultural discharges are drawn into the California Aqueduct and the Delta Mendota Canal, as well as into the Contra Costa Canal.

The data at the Contra Costa Canal Intake are reported in terms of mean daily concentrations of chlorides and TDS, rather than mean tidal cycle concentrations. They show that the objectives were achieved during the 1975-76 water year, which ended September 30, 1976. The maximum mean daily chloride concentration observed during the period was 159 mg/1 near the end of September. Chloride levels remained at or below 100 mg/1 from October 1, 1975, through June 2, 1976, a period of 246 days, or 67 percent of the year. The maximum mean daily total dissolved solids concentration was 648 mg/1 on September 30, and TDS levels were at or below 380 mg/1 on 347 days, or 95 percent of the year. (The 19 days when TDS rose above 380 mg/1 occurred intermittently between mid-July and the end of September.)

Although the data cited above show achievement of the Contra Costa Canal Intake salinity objectives during the water year, they do not reflect the fact that salinities substantially lower than the maximum limitations occurred during much of the year. Further perspective is provided by two selected statistics. Mean daily chloride concentrations of 50 mg/1 or less were observed at the Canal intake on 186 days, or 51 percent of the year. Mean daily TDS levels of 190 mg/1 or less occurred on 129 days, or 35 percent of the year. These lower salinities, which are one-half of the objective limits, were observed during the first part of the water year, before the full effects of the drought began to be felt in the Delta.

Criteria for Protection of Western Delta Municipal and Industrial Use

The Basin 5B Plan states that at Antioch, on the San Joaquin River, the mean daily total dissolved solids concentration for any 14 consecutive days is limited to 450 mg/1 for a period of at least 120 days in a dry water year. For water year 1976 (October 1, 1975 through September 30, 1976) this objective was not fully achieved. From October 1, 1975 through January 25, 1976, a period of 117 days, mean daily TDS at Antioch was in the range of 111-428 mg/1. On January 26, 1976, TDS rose above the limit for the remainder of the water year, reaching a peak of 2 828 mg/1 on July 12, 1976. The affected water users arranged for alternative supplies from the Contra Costa Canal.

Figure 21 compares Antioch TDS concentrations with SWP impacts on Delta outflow during the first four months of 1976. Note that in January, when TDS levels rose above the 450 mg/1 limit, SWP operations were resulting in significant reductions of Delta outflow, as the Project was simultaneously increasing storage in its reservoirs and exporting water from the southern Delta. The Project did not begin to augment Delta outflow until late March. Evidently, Project operations could have been adjusted in late January to help achieve full compliance with this criterion at the expense of reduced storage or exports, or both. However, in retrospect, such action clearly would have impaired the Project's ability to deal with other adverse Delta salinity conditions that developed as the drought continued. For example, see the discussions of SWP responses to increasing salinities at: Antioch during the striped bass season in April, Chipps Island during June and July, and Emmaton and Blind Point in December, presented elsewhere in this chapter. Also see the discussion of SWP-FCVP coordination in Chapter III.

Criteria for Protection of Striped Bass

The Basin 5B Plan provides for protection of striped bass during the spring spawning period by specifying maximum 14-day mean electrical conductivity levels in the San Joaquin River of 1 500 microsiemens/cm at Antioch and 550 microsiemens/cm at Prisoners Point. These criteria are effective for a five-week period beginning at the time water temperature at Antioch reaches 15.6C (60°F).

The practical application of these criteria is complicated by at least two factors. First, the combination of salinity limitations with water temperature is designed to promote at least minimum rates of spawning by adult bass. In 1976, water temperatures at Antioch hovered in a narrow range around the triggering value for several days at the onset of the spawning period, thus hindering a precise determination of the date of application of the criteria. Second, a further purpose of these criteria is to protect the survival of bass eggs from the time of spawning through hatching, a period of only a few days. The objectives, however, are stated in terms of 14-day average conductivities to account for normal tidal variations during a two-week cycle. When conductivity is rising and approaching the specified limits, as it did at Antioch during 1976, the rise of 14-day average conducivity lags behind that of the daily average. Eggs may then be spawned in water that exceeds the limits even though the 14-day average objectives are being temporarily achieved at the time of spawning.

Therefore, in 1976, SWP operators consulted with biologists of the California Department of Fish and Game to determine, on the basis of preliminary field observations of striped bass spawning, when to begin applying the criteria. The date selected was March 29, 1976.

Figure 22 presents the 14-day mean conductivities at Antioch and, for comparison, the daily mean conductivity values between March 15 and May 11, 1976. Note that although the daily average began to exceed 1 500 microsiemens/cm on March 18, the 14-day running average did not exceed that value until March 26. The Antioch conductivity was above 1 500 microsiemens/cm on March 29, when the criterion was triggered, and reached a peak, on a 14-day average basis, of 2 225 microsiemens/cm on April 9.

Figure 22 also shows the effect of SWP operations during the period on weekly average Delta outflows. The Project had been reducing outflow for the first three months of the year. During the week of March 29, in an attempt to achieve compliance with the Antioch criterion, the Project began augmenting Delta outflow through a combination of reservoir releases and sharply lowered

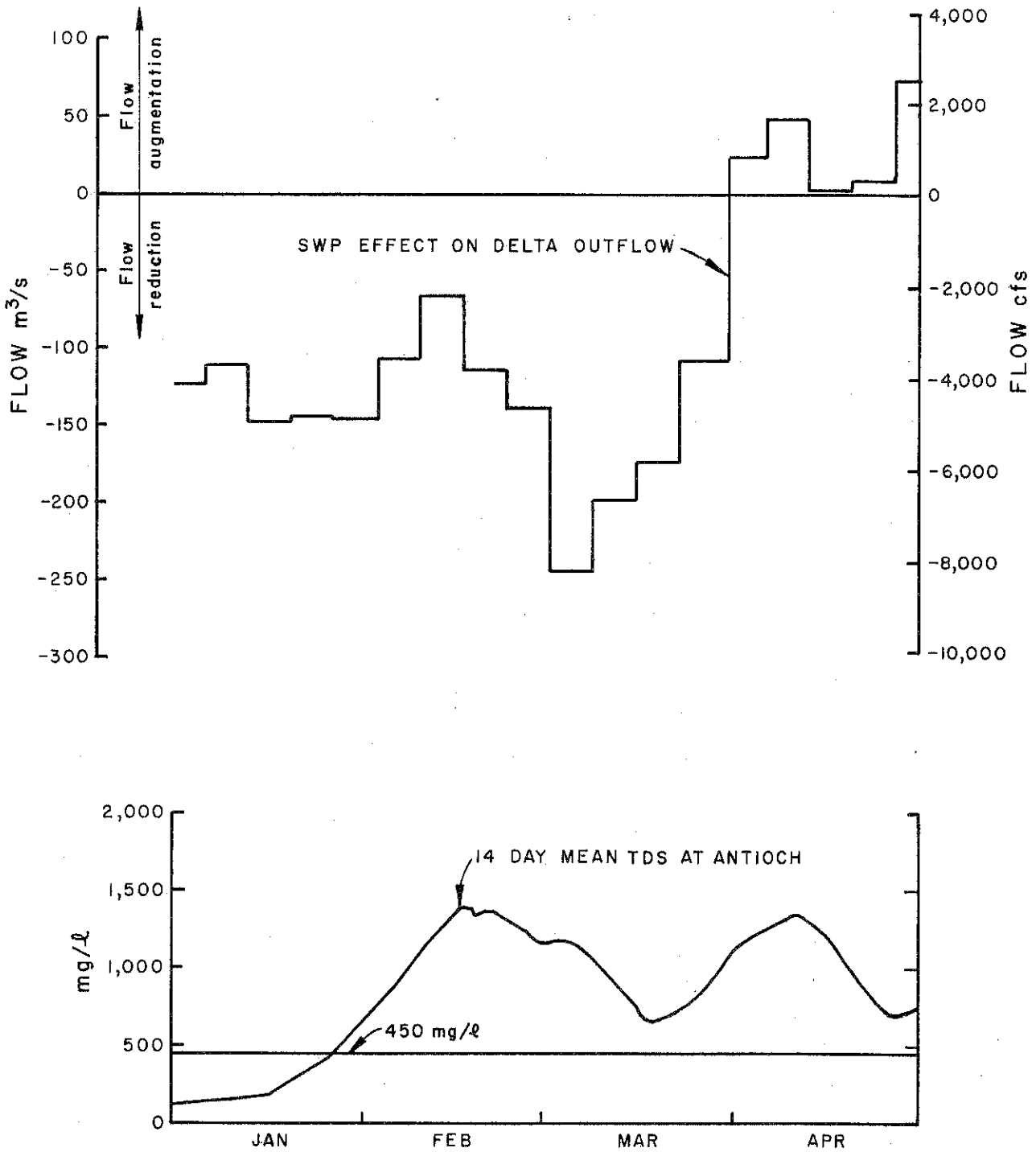


FIGURE 21

TDS CONCENTRATIONS AT ANTIOCH

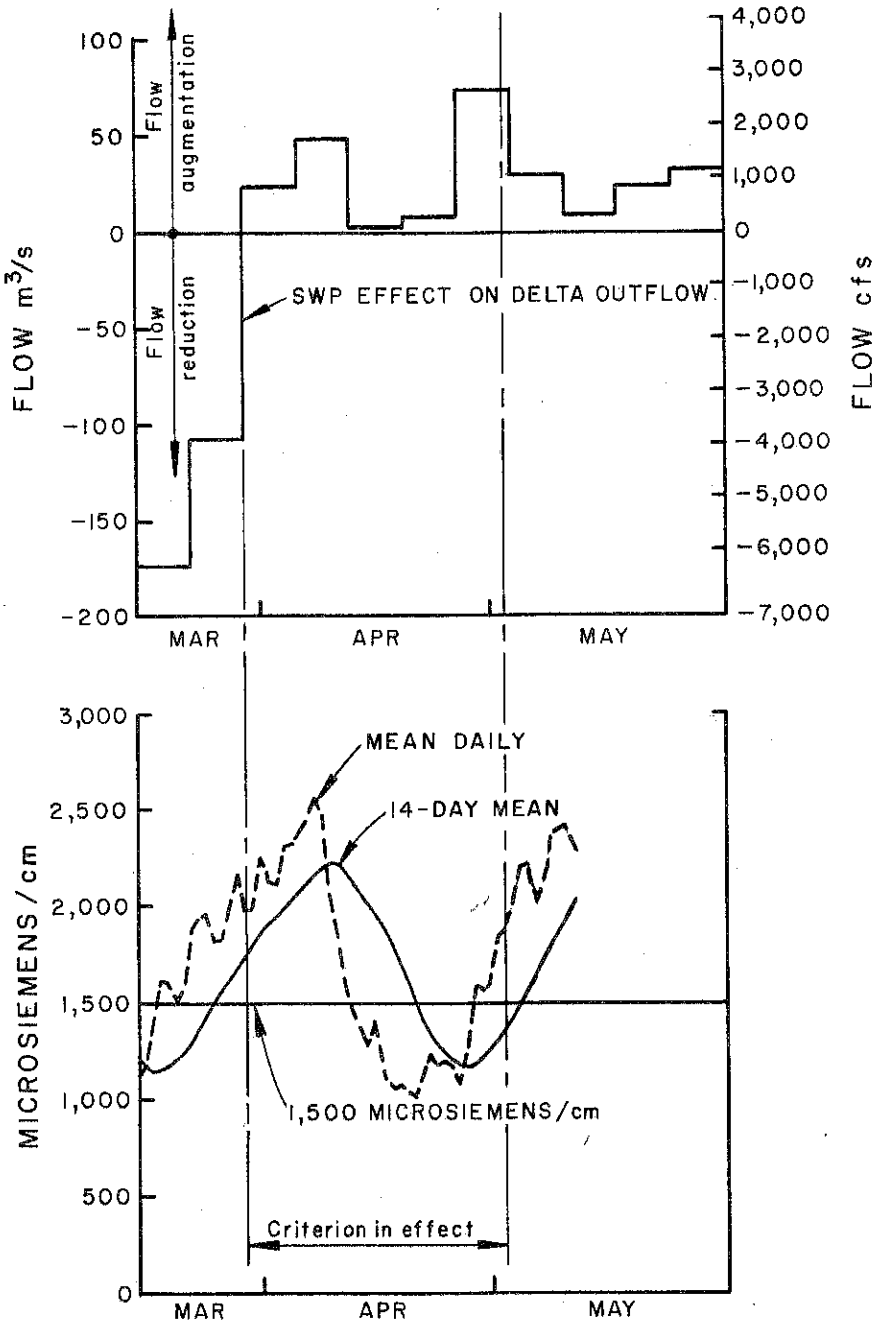


FIGURE 22

ELECTRICAL CONDUCTIVITY AT ANTIOCH

Delta withdrawals. These operational adjustments helped reduce daily average conductivity at Antioch to less than 1 500 microsiemens/cm on April 12, but the 14-day average did not fall below the criterion until April 21. Although the daily average again rose above 1 500 microsiemens/cm beginning on April 28, the 14-day average specified in the criterion was not exceeded again during the 5-week period ending on May 2.

In summary, during the 5 weeks from March 29 to May 2, the 14-day average conductivity at Antioch exceeded the limit of 1 500 microsiemens/cm for 26 days from March 29 through April 20. During these five weeks, the State Water Project augmented Delta outflow by a total of 95 million cubic metres (77,000 acre-feet).

Electrical conductivity is not routinely measured at Prisoners Point. However, the 350 microsiemens/cm objective was met at that station during 1976, as indicated by measurements at San Andreas Landing, which is farther downstream and thus in a zone of higher ocean salinity intrusion. During the five-week period from March 29 through May 2, the 14-day mean electrical conductivity at San Andreas Landing was in the narrow range of 166-194 microsiemens/cm, well below the 350 microsiemens/cm limit.

Data collected by the Department of Fish and Game regarding the extent of striped bass spawning and the survival of eggs during the spring of 1976 have not yet been fully analyzed.

Criterion for Protection of Neomysis

The Basin 5B and Basin 2 plans include an objective designed to protect the opossum shrimp, Neomysis mercedis, an important component of the diet of striped bass. As 1976 began, the objective was a maximum mean daily chloride concentration of 4 000 mg/l at the westerly end of Chipps Island. On June 17, the objective was changed by the State Water Resources Control Board to limit the 14-day mean chloride level to 4 000 mg/l at the O&A Ferry slip, near the midpoint of Chipps Island.

Mean daily chloride data at the westerly end of the Island are not available. Measuring equipment was installed at the O&A Ferry slip in May, and data are available beginning on May 13 and for the remainder of the year. Chloride concentrations at Chipps Island during 1976 are presented on Figure 23, together with the calculated effect of the State Water Project on Delta outflow.

Between May 13, when the recorder was installed, and June 16, the mean daily chloride concentration was below 4 000 mg/l except for one day. On May 16, a rapid salinity fluctuation was observed, and the chloride level rose to 4 227 mg/l, but dropped to 3 476 mg/l the following day. Note, however, that the O&A Ferry location is upstream of the westerly end of Chipps Island, where salinities are somewhat higher, and the mean daily maximum values may have been exceeded more frequently than this record indicates.

Relatively large fluctuations in day-to-day measurements of ocean salinity, such as that observed on May 16 at Chipps Island, are common in the Delta-Bay estuary. Ocean salinity concentrations at stations such as Chipps Island are in a state of continuous change, rising and falling over fairly wide ranges with the flood and ebb of the tide. The tidal range varies from day to day, and so does the range of salinity at such stations. The mean daily salinity is computed by averaging a number of frequent instantaneous values observed during the day. It is subject to regular, perodic fluctuations over a two-week cycle, as indicated by the fragmentary data for mid-May to mid-June presented on Figure 23. These more or less regular variations are smoothed in the computation of the 14-day running average salinity.

Variations in the tidal range are not completely regular, however, random

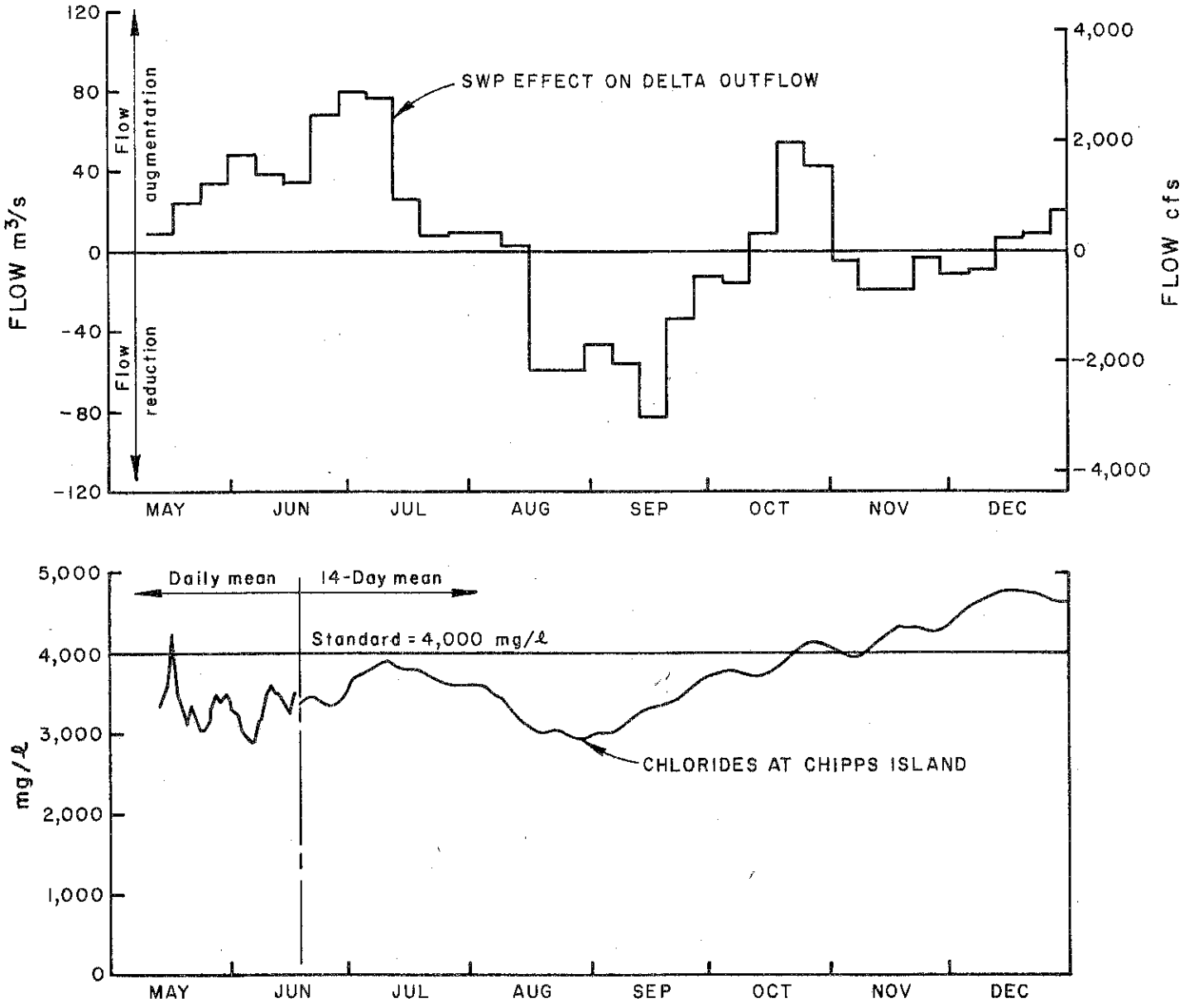


FIGURE 23

CHLORIDE CONCENTRATIONS AT CHIPPS ISLAND

short-term changes occur frequently. For example, changes in wind velocity can significantly affect tide ranges and, hence, salinity ranges in the Delta and Bay. Changes in barometric pressure over the ocean and estuary may also have pronounced effects. Such factors, acting together with other essentially random forces, can lead to sudden changes in salinity like that measured on May 16 at Chipps Island.

It is highly probable that when water resources projects are being operated near the limits of Delta salinity criteria, with the dual objectives of protecting the Delta and conserving scarce water supplies, the criteria will occasionally not be satisfied on a short-term, transitory basis. Unfortunately, the times and places of such nonachievement cannot be reliably predicted in time to take corrective action. The alternative to accepting the kind of nonachievement observed at Chipps Island on May 16 appears to be the use of sufficient additional water for outflow to maintain salinities well below established limits, thus minimizing the risk of exceeding such limits.

Beginning June 17, the Chipps Island objective was based upon the 14-day mean chloride concentration, measured at O&A Ferry. This limit was approached, but not exceeded, in mid-July, when the salinity reached an intermediate peak of 3 901 mg/l. Chipps Island salinity receded to less than 3 000 mg/l in late August, the result of higher outflows associated with a brief storm period. As the salinity began to approach the limit again in October, SWP operations were adjusted to augment Delta outflow, but the limit was exceeded from October 23 through November 1. SWP operations resulted in diminished Delta outflows beginning the week of November 1, when compliance with the objective was temporarily restored. The SWP continued to decrease outflow through mid-December even though the 4 000 mg/l limit was again exceeded beginning November 10. The Project began to augment outflow again during the week of December 13, at rates up to 9 cubic metres (314 cubic feet) per second, but the 14-day salinity remained above the limit for the remainder of the year, reaching a maximum of 4 755 mg/l on December 18.

Criterion for Protection of Suisun Marsh

The Basin 2 Plan includes a salinity objective designed to protect the Suisun Marsh as habitat for migratory waterfowl. Waters surrounding and adjacent to the marsh are to be maintained within a mean monthly high-tide TDS concentration limit of 18 000 mg/l.

Comprehensive salinity measurements in the Suisun Marsh area are available for a station at Port Chicago. At that station, the mean monthly high-tide salinity during 1976 reached a maximum in December of 16 847 mg/l TDS, which is within the limit.

Water Quality of SWP Delta Exports

The State Water Project's contracts with its customers include a series of water-quality objectives stated in terms of maximum concentrations of selected constituents. In order to help assure achievement of these objectives at the points of delivery to its contractors, the SWP strives to maintain water quality at the Delta Pumping Plant at levels that allow for a 10-percent increase in concentrations during conveyance southward.

Table 4 compares the objectives with water-quality measurements at the Delta Pumping Plant during 1976. The objectives were met at the Delta, except that the sodium percentage objective of 50 percent was not met for 6 months from July through December, when values ranged from 56-59 percent. Note also that the chloride objective of 110 mg/l was achieved, but without a safety factor.

SWP water quality at locations south of the Delta is summarized in Bulletin

TABLE 4

SWP EXPORT WATER QUALITY AT DELTA PUMPING PLANT - 1976

Constituent	Objective		Maximum Values
	Monthly Average	Maximum	
Total Dissolved Solids, mg/l	440		352 (December)[1]
Total Hardness, mg/l	180		120 (December)[1]
Chlorides, mg/l	110		110 (December)[1]
Sulfates, mg/l	110		40 (October)[1]
Boron, mg/l	0.6		0.3 (December)[2]
Sodium Percentage	50		59 (December)[1]
Fluoride, mg/l		1.5	0.2 (5 months)[2]
Lead, mg/l		0.1	0.00[2]
Selenium, mg/l		0.05	0.01 (2 months)[2]
Hexavalent Chromium, mg/l		0.05	0.00[3]
Arsenic, mg/l		0.05	0.00[2]
Iron and Manganese together, mg/l		0.3	0.30 (May)[2]
Magnesium, mg/l		125.0	21 (December)[2]
Copper,mg/l		3.0	0.03 (May)[2]
Zinc, mg/l		15.0	0.01 (May)[2]
Phenol, mg/l		0.001	0.001(September)[3]

[1] Flow weighted averages based on correlations with electrical conductivity

[2] Laboratory analysis of monthly samples

[3] Laboratory analysis of semi-annual samples

132-77. The percentage-sodium objective was not met at several delivery points, but all other objectives were achieved.

Salinity Measurements as Indicators of the Reliability of Delta Outflow Estimates

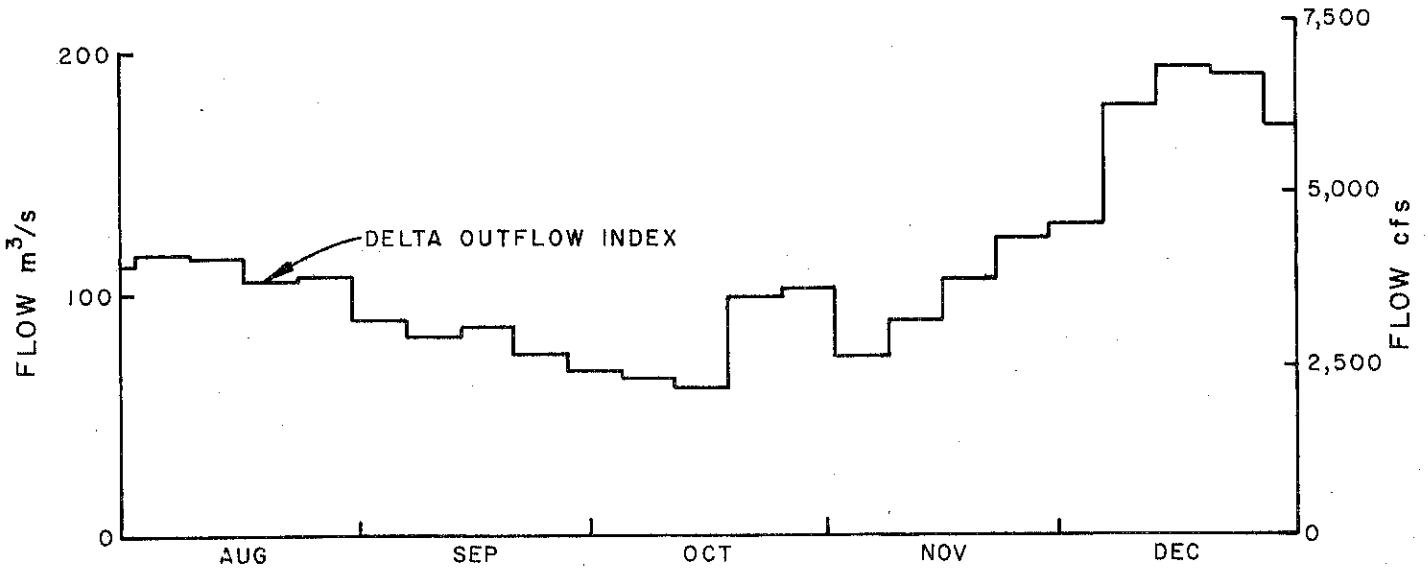
Chapter III discusses the importance of reliable estimates of Delta outflow from the standpoints of Project operation and future planning. Two estimates, the Delta outflow index and a "calculated Delta outflow", are compared, and it is shown that in 1976, they gave results that differ occasionally by substantial amounts. When these estimates are compared with observations of ocean salinity intrusion data for 1976, it becomes evident that in addition to being widely different, the two estimates are sometimes obviously inconsistent with the measured salinity data.

Ocean salinity intrusion in the Delta should vary inversely with Delta outflow. That is, as outflow increases, salinity should tend to decrease or, at least, to increase more slowly. The relatively rapid increase in Delta salinity intrusion during late 1976 should thus have been associated with declining Delta outflows. Nevertheless, the Delta outflow estimates discussed in Chapter III were in rising trends during the period of increasing intrusion.

Figure 24 presents the weekly average Delta outflow index for the last five months of 1976 together with the corresponding 14-day average chloride concentrations at Chipps Island, the western limit of the Delta. Observe that at the beginning of September, the index was falling while chloride levels were staring to rise. In mid-October, however, the index began to increase fairly rapidly, from 61 cubic metres (2,155 cubic feet) per second during the week of October 11 to a maximum of 195 cubic metres (6,811 cubic feet) per second in mid-December. Chipps Island salinity, however, continued its steady rise.

Figure 25 presents a similar comparison of Chipps Island chloride concentrations with the "calculated Delta outflow" described in Chapter III. The "calculated Delta outflow", unlike the index, is based in part on observed rainfall data. It is therefore somewhat more variable; however, a steadily rising trend can be seen beginning in mid-September, while Chipps Island chlorides were also beginning their upward trend. It is note worthy that the chloride measurements do not appear to respond noticeably to the relatively large surge in calculated outflow near the end of September. The calculated outflow increment for the week of September 27 was 149 cubic metres (5,266 cubic feet) per second and represented a one-week increase in outflow of about 90 million cubic metres (73,000 acre-feet) over that of the previous week.

These selected data not only demonstrate that the two outflow estimates differ substantially on occasion, but also suggest that both are inconsistent with observed salinity data from time to time. They underscore the need for improvement of existing procedures for estimating the several components used to derive Delta outflow.



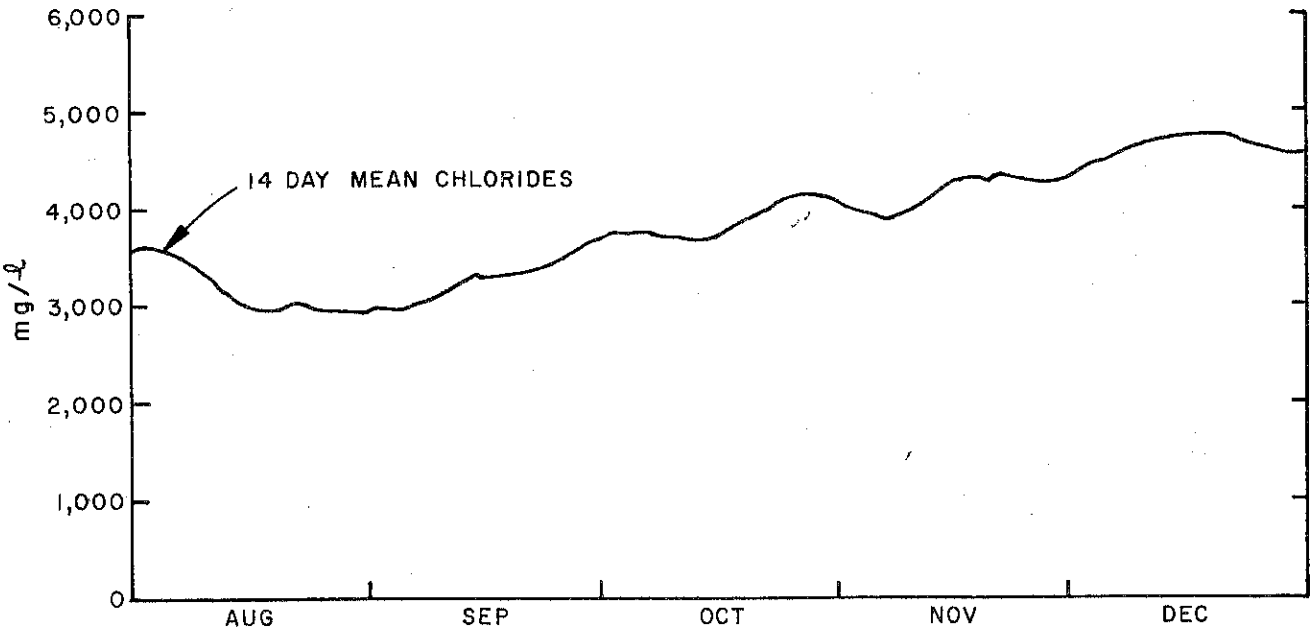


FIGURE 24

CHLORIDE CONCENTRATIONS AT CHIPPS ISLAND

COMPARED WITH DELTA OUTFLOW INDEX

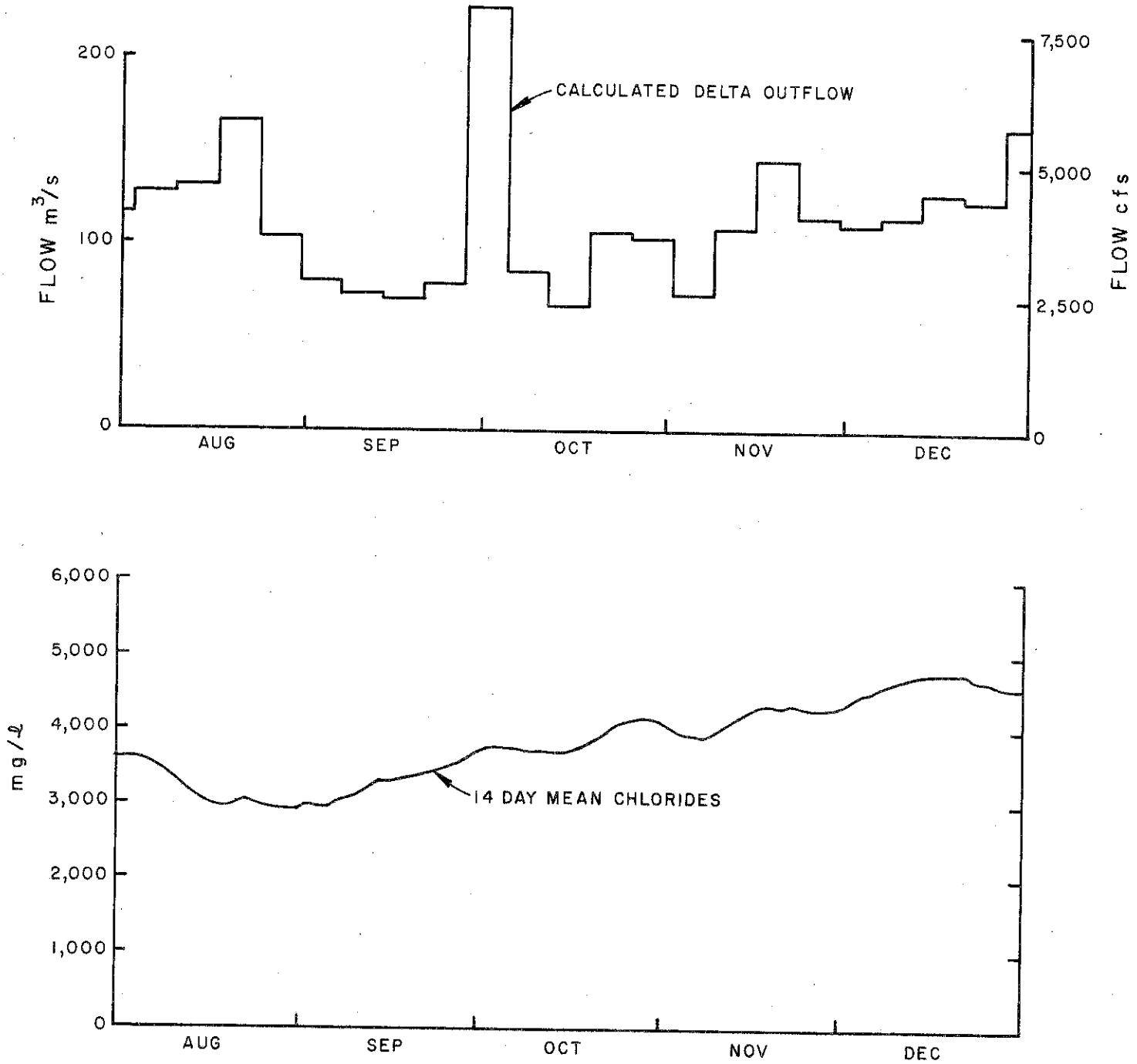


FIGURE 25

CHLORIDE CONCENTRATIONS AT CHIPPS ISLAND COMPARED WITH CALCULATED DELTA OUTFLOW

V. DELTA WATER QUALITY MONITORING

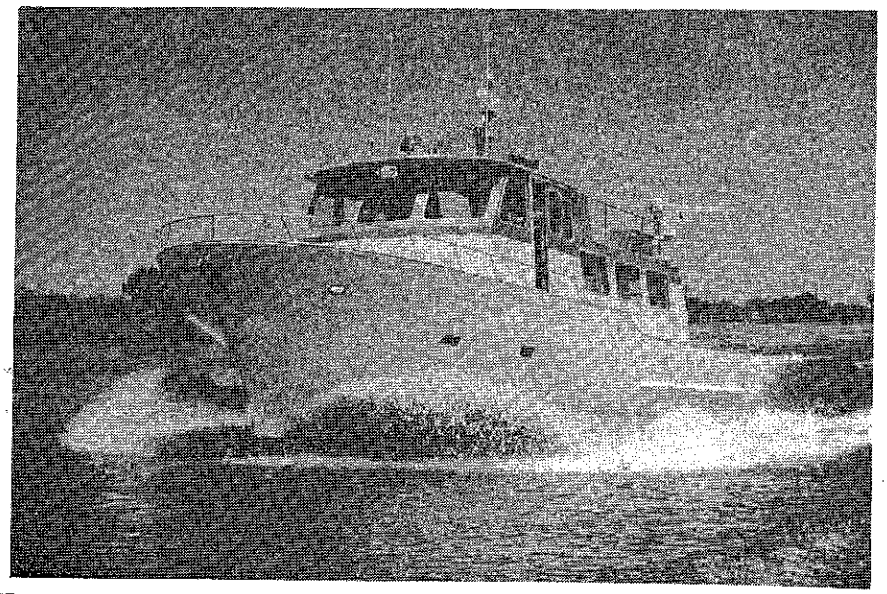
The State Water Project recognizes that its present and future operations have potential water-quality implications in the Delta, which extend beyond considerations related to salinity conditions such as those discussed in Chapter IV. Accordingly, the Project conducts a routine monitoring program that measures a broad range of physical, chemical, and biological water-quality characteristics at locations throughout the Delta and Suisun Bay region. The program provides data necessary to define relationships between Project operations and the Delta's fish and wildlife resources, and is also designed to meet data needs identified by the State Water Resources Control Board.

In fiscal year 1976-77, the budget for the monitoring program was $637,000. The monitoring network included the 28 stations listed on Table 5 and shown on Figure 26. In general, the stations were visited twice each month during 1976. In addition, continuous water-quality profiles were measured semi-monthly from the Carquinez Strait to Rio Vista on the Sacramento River and to Stockton on the San Joaquin River.

Much of the data collection was performed using the Project's new laboratory boat, the M.V. San Carlos, which was placed in service in March, 1976. The San Carlos, a 17 metre (56 foot) craft costing about $320,000, is equipped with an array of scientific equipment that permits many analyses to be performed on board, thus reducing the need for the preservation and transportation of samples to land-based laboratories.

The long list of water-quality characteristics included in the monitoring program includes measurements of: mineral constituents, pesticides, heavy metals, algae, nutrients, and dissolved oxygen. Complete tabulations of the data have been published by the Department of Water Resources.[1] The data are used extensively by the Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary, a cooperative effort by the Departments of Water Resources and Fish and Game, the U. S. Fish and Wildlife Service, and the Bureau of Reclamation (See Chapter VI).

In addition to the routine monitoring



The M. V. San Carlos

(1) Department of Water Resources, "Sacramento-San Joaquin Delta Water Quality Surveillance Program", June 1977.

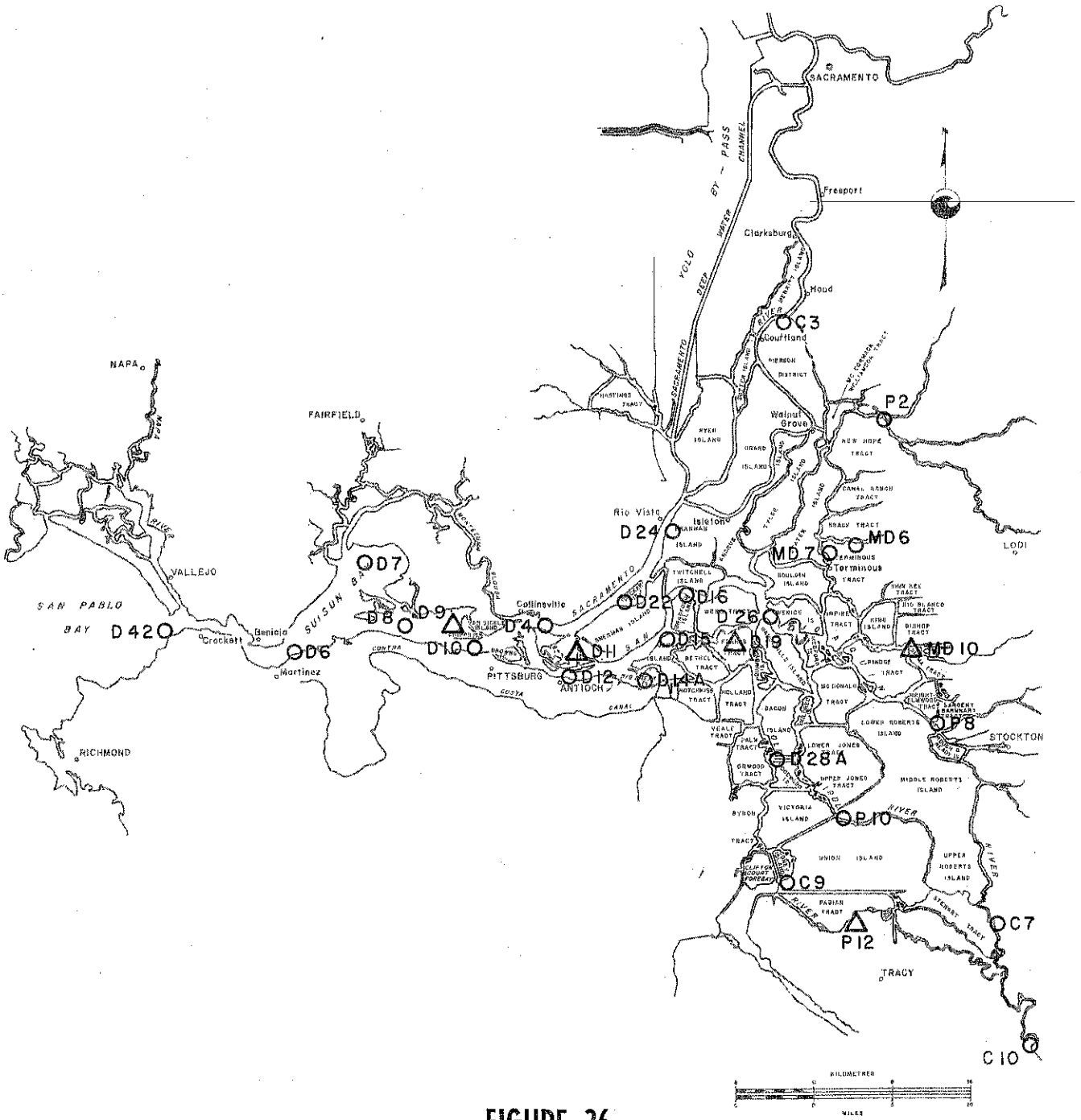


FIGURE 26

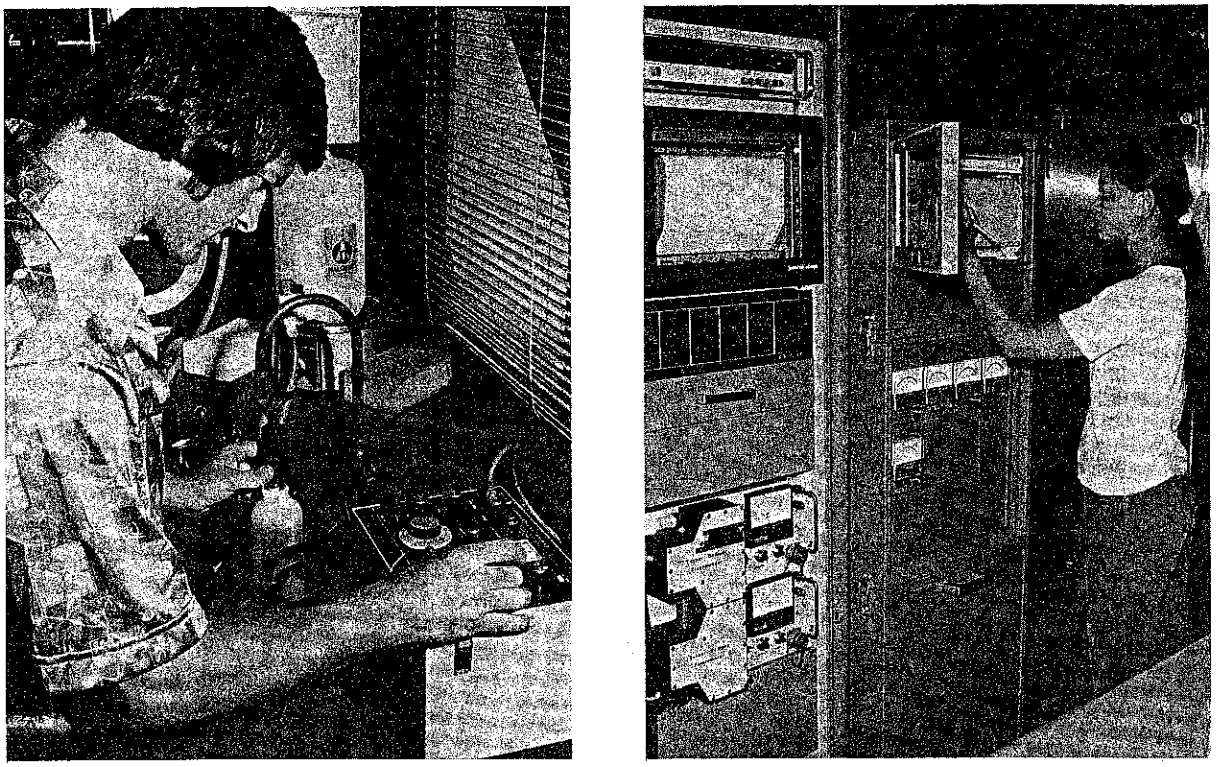
DELTA WATER QUALITY MONITORING PROGRAM,
1976 MONITORING STATION LOCATION MAP

TABLE 5

DELTA WATER QUALITY MONITORING PROGRAM, 1976

LIST OF MONITORING STATIONS

	Station Number (See Figure 26)
Sacramento River at Greene's Landing	C3
San Joaquin River at Mossdale Bridge	C7
West Canal at Mouth of Intake to Clifton Court Forebay	C9
San Joaquin River near Vernalis	C10
Sacramento River above Point Sacramento	D4
Suisun Bay off Bulls Head Point near Martinez	D6
Grizzly Bay at Dolphin near Suisun Slough	D7
Suisun Bay off Middle Point near Nichols	D8
Honker Bay near Wheeler Point	D9
Sacramento River at Chipps Island	D10
Sherman Lake near Antioch	D11
San Joaquin River at Antioch Ship Channel	D12
Big Break near Oakley	D14A
San Joaquin River at Jersey Point	D15
San Joaquin River at Twitchell Island	D16
Frank's Tract near Russo's Landing	D19
Sacramento River at Emmaton	D22
Sacramento River below Rio Vista Bridge	D24
San Joaquin River at Potato Point	D26
Old River Opposite Rancho Del Rio	D28A
San Pablo Bay near Rodeo	D42
Sycamore Slough near Mouth	MD6
South Fork Mokelumne River below Sycamore Slough	MD7
Disappointment Slough at Bishop Cut	MD10
Mokelumne River near Thornton	P2
San Joaquin River at Buckley Cove	P8
Middle River at Borden Highway	P10
Old River at Tracy Road Bridge	P12

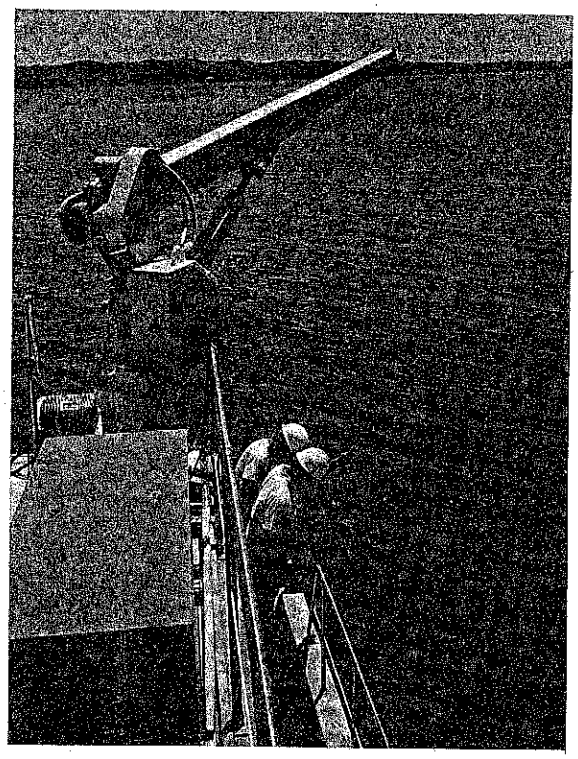


Electronic Water Quality Monitoring Equipment on the San Carlos

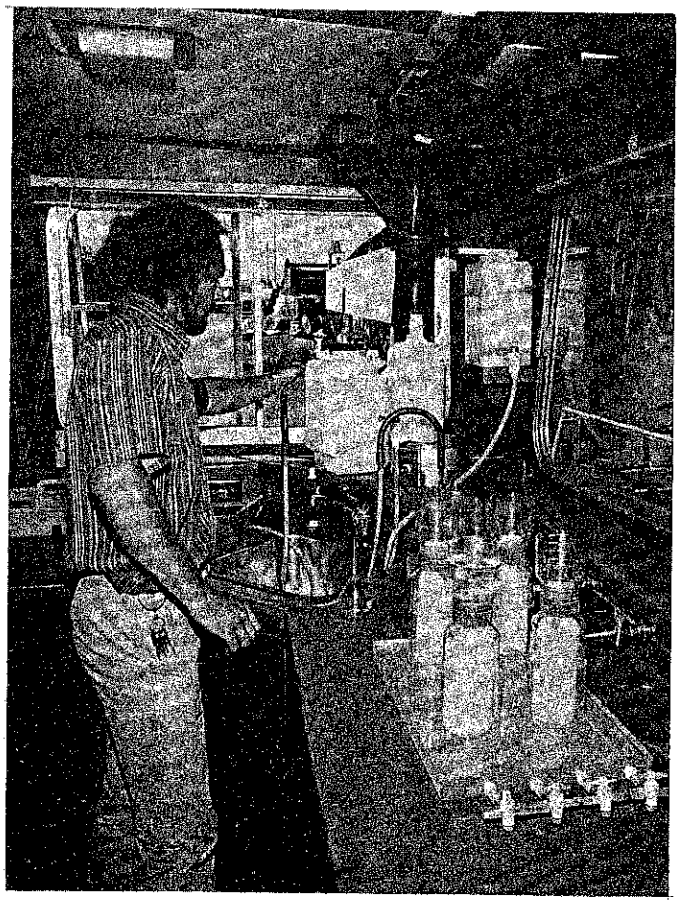
program, the Department of Water Resources conducts or participates in a number of special-purpose data collection efforts. During 1976, these included measurements associated with the closures of Sutter Slough and Old River, described in Chapter III.

Of particular interest during 1976 were the measurements of the amounts of algae in the waters of the Delta and Bay. Algae populations are important because they form the base of the food chain on which other aquatic life depends. Excessive populations may have adverse environmental effects, however. High algae levels may deplete dissolved oxygen in the water through respiration and, on their death, may lead to nuisance conditions. Prior to 1976, some scientists feared that low Delta flows would lead to algae populations sufficiently large to cause environmental harm. During the 1976 drought, however, when flows reached low values for an extended period, water-quality measurements showed that at most stations, algae levels were significantly lower than those observed in wetter years. For example, at Honker Bay in the Suisun Bay area, and at Franks Tract in the Delta, summer algae levels, as measured by concentrations of chlorophyll, are usually greater than 20 micrograms per litre. In 1976, the observed summer chlorophyll concentrations at both stations were below 10 micrograms per litre.

Exceptions to this general condition occurred, most notably in the southeastern Delta, east of the diversion facilities of the SWP and FCVP. San Joaquin River inflows were low in volume but extremely high in concentrations of algae and nutrients, and the chlorophyll level in Old River near Tracy reached 364 micrograms per litre in May.



Sampling the Delta Water Environment from the San Carlos



Water Laboratory on the San Carlos

VI. DELTA FISH AND WILDLIFE

The State Water Project participates in the Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary, usually called the "Four Agency Program". The Study Program is an ongoing cooperative effort by the California Departments of Water Resources and Fish and Game, the U. S. Fish and Wildlife Service, and the Bureau of Reclamation. It includes a number of coordinated studies designed to define relationships between operations of the SWP and FCVP and important categories of Fish and Wildlife.

Financial support for the Program during fiscal year 1976-77 is summarized as follows:

Agency Support

Study Category	Dept. of Water Resources	*Bureau of Reclamation	Dept. of Fish and Game	Total
Fisheries	$ 168,000	$ 133,000	$ 932,000	$1,233,000
Fish Facilities	534,000	40,000	-	574,000
Suisun Marsh	11,000	146,000	11,000	168,000
Water Quality	455,000	119,000	-	574,000
Total	$1,168,000	$ 438,000	$ 943,000	$2,549,000

* The Bureau of Reclamation's financial support includes funding of participation by the U. S. Fish and Wildlife Service.

Detailed descriptions of progress of the several studies are published annually by the four cooperating agencies. The following paragraphs present selected highlights of the information assembled during 1976.

Striped Bass Studies

The Interagency Program includes a series of data collection and analysis programs which assess the Delta's striped-bass populations over their entire life cycle which begins with spawning in the spring of each year. The studies are conducted by the Department of Fish and Game. Results of the striped-bass studies in 1976 are summarized as follows:

1. Striped bass spawning survey: Fine mesh nets were used to sample for striped bass eggs in the San Joaquin River from Broad Slough to Venice Island between April 12 and May 28. Results have not yet been analyzed. The Department of Fish and Game reports that the survey was only partially successful, because the nets became clogged with filamentous algae during the survey period.

2. Survival of young striped bass: The survival of bass during the several weeks following spawning is assessed by measurement of a "summer striped bass index" of the relative abundance of fish. Young bass are sampled at selected stations in the Delta and Suisun Bay, when their average length is 3.8 centimetres (1.5 inches). The summer striped-bass index for 1976

was 35.5, the third lowest value observed since measurements began in 1959. (From 1959 through 1976, the index ranged from 33.9 in 1959 to 118.4 in 1965 and averaged 67.7). Statistical analyses prepared by the Department of Fish and Game have shown that the striped bass index increases as Delta outflow rises, but decreases as Delta exports by the SWP and FCVP increase.

3. First-year survival of striped bass: Survival of bass during their first year of life is assessed by trawling surveys during the fall and winter at 80 stations from the Delta through San Pablo Bay. The surveys lead to the calculation of a fall/winter index of the relative abundance of striped bass during October through December. In 1976, the fall/winter striped bass index was 517, the lowest value observed since surveys began in 1967. The highest fall/winter index measured to date was 8951 in 1967. Since 1967, the index has averaged 4039 index units. Statistical analyses show a correlation between the fall/winter index and the summer index discussed above.

4. Adult striped-bass studies: The size of the adult bass population is estimated each year to determine its relationship to survival during the first year of life. "Adult" fish are those greater than 41 centimeters (16 inches) long, the minimum size anglers may keep. Most striped bass reach this length three years after spawning.

   Since 1969, the adult population has been estimated by counts of recaptured fish marked during the first year of their life. Supplementary estimates utilize catch information obtained from anglers. Data for 1975 and 1976 have not yet been fully analyzed. For the years 1969 through 1974, the population estimate of adult bass ranged between 1.6-1.9 million fish. Delta flows during the first year of life of these bass varied over a wide range, and attempts to relate adult population to first-year flows have been inconclusive. The Department of Fish and Game reports, however, that analysis of sports fishing records over the past 40 years does suggest a correlation between Delta outflows during the first year of life and subsequent estimates of the adult striped-bass population.

Neomysis Studies

The opossum shrimp, Neomysis mercedis, has been found to be an important component of the diet of striped bass, especially during the first year of life of the fish. The Neomysis population has been monitored each year since 1968 to determine the factors affecting its size, as well as its relationship to striped bass survival. During 1976, Neomysis samples were taken at 47 stations throughout Suisun Bay and the Delta. Biweekly surveys were conducted from April through October, with monthly surveys in March, November, and December. Analyses are based on the estimated number of organisms greater than 4 millimetres long.

In 1976, the Western Delta-Suisun Bay Neomysis population index was 19. This value is less than one-half the lowest index previously calculated which was 41 in 1972. Since 1968, the highest index was 63 in 1969, and the index was averaged 46.

Past studies have shown that Neomysis populations fall as salinity levels rise. Low populations observed in 1976 are thus partly explained by salinity conditions caused by low Delta outflows. In addition, however, Neomysis levels are correlated with the abundance of algae, which form a part of their food supply. As discussed in Chapter V, algae concentrations were unusually low during the year. These interrelationships are the subject of continuing investigation by the Interagency Ecological Study Program.

King Salmon Studies

Comprehensive studies of factors impacting salmon populations migrating through the Delta have not yet begun. Data from a pilot program and certain other studies of the Department of Fish and Game are available, however.

1. In the fall of 1976, marked juvenile salmon were released at five Delta sites, as discussed in Chapter III in the description of the closure of Sutter Slough. Recaptures of these fish at Chipps Island indicate that salmon migrating down the main stream of the Sacramento River will survive in larger numbers than those passing through the Central portion of the Delta.

2. The fall salmon run on the Sacramento River and its tributaries totalled 185,000 fish, down from 190,000 in 1975.

3. The fall salmon run on the San Joaquin River system totalled 4,000 fish, down from 4,500 in 1975.

American Shad Studies

Delta populations of American shad are indicated by the numbers of fish captured during trawl samples collected in the Delta and Bay during the fall. The American shad population index for 1976 was 276. For the period 1967 through 1976, the shad index ranged from 262 in 1972 to 2658 in 1969. The average index from 1967-1976 was 972. The fall shad index has been correlated with Delta inflow during April, May and June, suggesting that Delta inflow regulates the amount of suitable spawning and nursery habitat.

Water Quality Studies

Delta water quality studies led to the further development of analytical methods for forecasting changes in chemical and biological characteristics of the Delta's waters as affected by project operations.

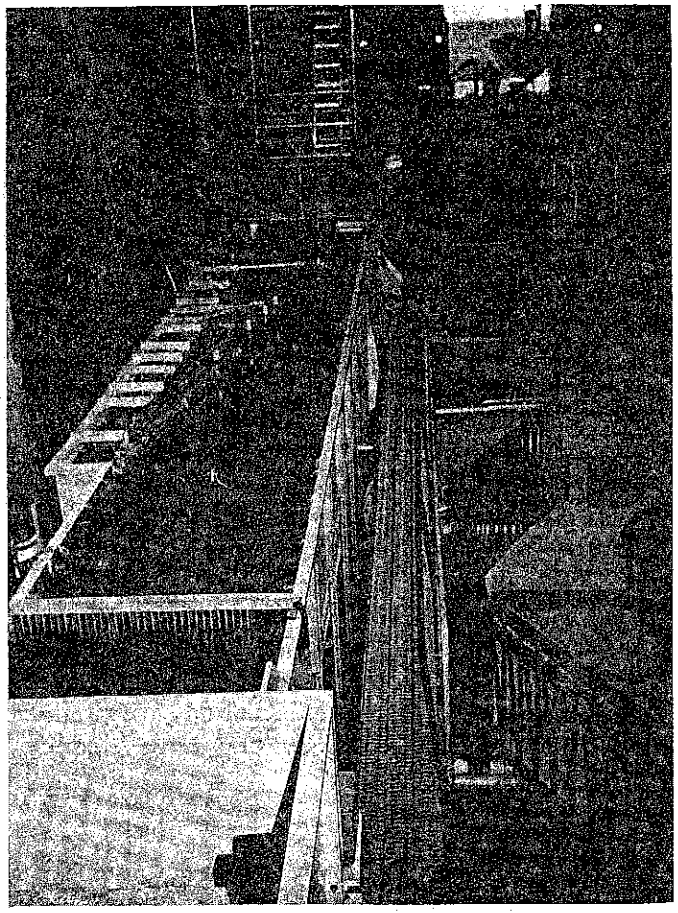
The water quality studies focus on relationships among Delta flows, local waste discharges, a series of environmental characteristics including complex circulation patterns in the Delta-Bay estuary, and the production of algae which form the base of the food chain for the region's aquatic life. As discussed in Chapter V, algae populations during 1976 were lower than expected or predicted by the available analytical procedures. Delta water quality data assembled by the State Water Project were used to modify the procedures. It appears on a preliminary basis that lower algae levels are associated with increasing ocean salinity intrusion, although a cause-and-effect relationship has not been established. Evaluation of this phenomenon by the Four Agency Program continues.

Other Studies

In addition to the programs described above, the Interagency Ecological Study Program continued a number of study programs designed to provide added understanding of matters related to the Delta and water resources project operation. Details of the following efforts are described in the Program's annual reports:

1. Fish facility studies evaluated mechanical and biological considerations associated with the design of fish screens at SWP and FCVP diversion facilities.

2. Suisun Marsh studies continued to assess alternatives for marsh management designed to protect waterfowl habitat.



Delta Fish Screen Test Facility

Waterfowl Use of the Suisun Marsh

ADDENDA

Addendum 1
DATA SOURCES

The data summarized in Appendix E to DWR Bulletin 132-77 have been derived from several sources. The following published data sources have been used:

Department of Water Resources Publications

1. State Water Project Reports of Operations, January through December, 1976.

2. State Water Project Daily Dispatcher's Reports for 1976.

3. "The California State Water Project - 1976 Activities and Future Management Plans", DWR Bulletin 132-77, November 1977.

4. "Water Conditions and Flood Events in California, Water Year 1975-76", DWR Bulletin 202-76, July 1977.

5. "The California Drought - 1976", May 1976.

6. "The California Drought 1977, An Update", February 15, 1977.

7. "Initial Study - Rock Barrier at Sutter Slough", DWR Central District February 1977.

8. 1976 Memorandum Report on Old River Closure, DWR Central District, June 16, 1977.

9. "Supplemental Agreement between the United States of America and the State of California for Coordinated Operation of the Central Valley Project and the State Water Project" (Draft), May 13, 1971.

10. "Sacramento-San Joaquin Delta Water Quality Surveillance Program - 1976", June 1977.

11. "Draft Environmental Impact Report - Peripheral Canal Project", August 1974.

State Water Resources Control Board Publications

1. "Water Quality Control Plan Report, Sacramento River Basin (5A), Sacramento-San Joaquin Delta Basin (5B), San Joaquin Basin (5C), undated.

2. "Water Quality Control Plan Report, San Francisco Bay Basin (2)", undated.

Bureau of Reclamation Publications

Central Valley Project Reports of Operations, January through December, 1976.

Unpublished data sources include the files of the Department of Water Resources' Division of Operation and Maintenance and Central District, files of the Central Valley Project's Tracy Field Division, a draft of the 1976 annual report of the Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary, and personal communications with staff of the Departments of Water Resources and Fish and Game, the State Water Resources Control Board, and the U. S. Bureau of Reclamation.

Addendum 2
EXAMPLE
DAILY DELTA WATER
QUALITY CONDITIONS REPORT

DELTA WATER QUALITY CONDITIONS DWR - O&M
Preliminary Data - subject to revision - 1976

		OUTFLOW		ANTIOCH		PT. CHICAGO		CHIPPS IS.		EMMATON	BLIND POINT				C.C. CANAL	
		daily		hi	mean	TDS		Cl-		E.C.	Cl-		E.C.		E.C.	Cl-
		cfs	14dm		1/2 tide	m.d.	30dm	m.d.	14dm	m.d. 31dm	m.d.	14dm	m.d.	14dm	m.d.	m.d.
NOV	11	3107	2865	2.8	1.20	13440	12618	4621	3932	3774	771	552	2927	2144	540	123
	12	3658	2873	2.8	1.23	13520	12689	4549	3989	3314	759	571	2885	2213	545	125
	13	3607	2879	2.3	1.05	12960	12717	4230	4034	3403	690	589	2638	2277	547	126
	14	3634	2877	2.2	0.95	12800	12735	4055	4087	2967	652	607	2503	2341	543	124
	15	3474	2910	2.0	0.53	11920	12737	3771	4127	2992	524	615	2044	2370	541	124
	16	3741	2987	2.1	0.45	12925C	12759C	3658	4147	2778	537	623	2091	2401	569	133
	17	3457	3053	2.3	0.45	13013C	12780C	3626	4157	2629	570	633	2207	2434	574	134
	18	3602	3131	2.6	0.53	13625C	12811C	3812	4168	2829	630	645	2453	2479	576	136
	19	4055	3242	2.8	0.65	13800C	12836C	4054	4160	3057	668	649	2560	2592	576	136
	20	4049	3353	3.1	0.80	14150C	12865C	4223	4153	3137	703	655	2685	2514	573	134
	21	4053	3453	3.2	0.88	14413C	12879C	4359	4157	3111	733	663	2794	2540	570	133
	22	4731	3619	3.3	0.93	14500C	12894C	4381	4164	3181	755	672	2870	2573	566	132
	23	5511	3834	3.1	0.80	13100E	12872C	4231	4150	3252	698	673	2666	2577	557	129
	24	4008	3906	3.1	0.98	13500E	12885E	4363	4138	3125	730	673	2783	2577	555	128
	25	4047	3973	2.8	1.05	13500E	12932E	4344	4114	3273	744	671	2832	2570	556	129
	26	4066	4002	2.6	0.95	13600E	12983E	4390	4107	2863	736	669	2802	2564	561	130
	27	4061	4035	2.18	0.70E	12800E	13010E	4133	4100	2520	673	668	2579	2560	577	136
	28	4037	4064	2.35	0.58E	11900E	13009E	3840	4085	2910	651	668	2498	2560	602	144
	29	3500	4066	2.3	0.53E	12250E	13017E	3963	4098	2873	642	676	2465	2590	563	131
	30	4000	4084	2.3	0.55E	12700E	13047E	4111	4131	2931	695	688	2658	2630	648	160
DEC	1	4376	4150	2.6	0.65E	13100E	13094E	4234	4174	3027	779	703	2957	2684	679	170
	2	5021	4251	2.6	0.70	13650E	13157E	4398	4216	NR	768	712	2917	2719	706	178
	3	5047	4322	3.0	0.98	14650E	13243E	4673	4260	NR	860	726	3247	2768	723	185
	4	5017	4391	3.2	1.18	15600E	13353E	4920	4310	3533	929	742	3494	2826	717	183
	5	5019	4460	3.2	1.18	15500E	13440E	4886	4348	3929	943	757	3544	2879	714	182

NOTE:

C = corrected data
E = estimated
Cl in mg/l

NR = no record
m.d. = mean daily
Tide in feet

14 dm = 14-day mean
E.C. in micro siemans/cm

Addendum 3
SUTTER SLOUGH BARRIER AGREEMENT

MEMORANDUM OF PERMIT

This Memorandum is made and entered into this 12th day of August, 1976, by and between the Department of Water Resources of the State of California, herein called Department, and North Delta Water Agency, herein called Agency.

RECITALS

(a) The Department proposes to install a temporary rock dam (herein called the dam) across Sutter Slough immediately upstream from the Sutter Island Upper Cross Road for the purpose of deflecting additional flows into the main channel of the Sacramento River, thence through the Delta Cross-Channel and into the interior delta to assist in maintenance of water quality in accordance with the prevailing delta quality objectives as established by the State Water Resources Control Board.

(b) Agency is formed for the purpose of negotiating, executing and enforcing agreements with the United States and with the State of California or either for:

(i) The protection of the water supply of the lands within the Agency against intrusion of ocean salinity; and

(ii) Assurance for the lands within the Agency of a dependable supply of water of suitable quality sufficient to meet their needs.

(c) Agency and its landowners are concerned as to the impact of the dam upon the level of water available in the slough for diversion downstream from the dam and the possible impact upon the quality of water available for such diversion during the period of the dam's installation unless written assurances are obtained from Department.

(d) Department desires approval by Agency of the installation of the dam and for Agency to withdraw or withhold any objection to approval of the installation of the dam by the State Reclamation Board or other regulatory agency or court.

TERMS OF PERMIT AND UNDERSTANDING

1. Agency gives its approval of the installation of the dam on the terms herein set forth and will not object to or oppose its installation before any regulatory State or Federal agency or court.

2. Department hereby agrees, during a period of two weeks prior to the installation of the dam, and at least once every two weeks while the dam exists:

(a) To measure water quality within Sutter, Miner, Steamboat Sloughs, and Cache Slough upstream from Liberty Cut, and determine the water quality in the Sacramento River at Rio Vista, Three Mile Slough, Emmaton, and Mayberry Slough.

(b) To measure tidal fluctuations within Sutter, Miner, Steamboat and Cache Sloughs.

3. Department will obtain, through Department personnel, the following information concerning all diversions within Sutter and Miner Sloughs that might be affected by the closure and are proposed to be used during the period of closure, as such effect is disclosed from the investigation of the Department or from the requests of the local districts or landowners:

(a) Measure a representative number of pumps and siphons for discharge capacity as mutually agreed upon.

(b) Elevation of pump bowls or siphon invert and, for centrifugal pumps, the elevation of the bottom of the intake and of the pump.

(c) Average pumping lift.

(d) Acreage and crops served by diversion.

4. Department will, during the period of closure, store a minimum of five portable pumps plus power plants within the affected area of the appropriate size to provide emergency water supply if required.

5. If the Department cannot provide alternate diversion capability within 24 hours of notice by the affected landowner, it will begin work immediately on breeching the dam, breeching to be completed within 48 hours to an extent sufficient to overcome the adverse effect on water supply.

6. Department will assure that water quality during the period of closure within Sutter, Miner and Steamboat Sloughs will not be more than 25 parts per million total dissolved solids higher than Greens Landing.

7. Department will assure that water quality during the period of closure at Rio Vista, Three Mile Slough, Emmaton, and Mayberry Slough will not be less than that which existed during the month of July.

8. Department will pay for the additional required energy to pump water during the period of closure based on the average pumping lift with and without the closure, taking into account pumping plant efficiencies.

9. Department is making this request to meet conditions in this drought year. Department does not intend to request the installation of the dam in future years unless water supply conditions, measured by inflow to the Delta, are similar or worse than this drought year and then only after preparation of an environmental impact report. Agency reserves the right to object to any future request to install dam.

10. Department will assure a minimum flow in the Sacramento River at Sacramento of 1,000 cfs during the period of closure.

11. Department will reimburse Agency within 90 days after removal of dam for legal, engineering and manager costs directly attributed to the closure or to monitoring its effects.

12. Department will remove the dam and return the channel location to its prior condition by December 20, 1976 or the date on which the flow in the Sacramento River at Sacramento reaches a sustained or forecasted of 30,000 cfs for a period of 72 hours, whichever first occurs. Department will agree to rock riprap the disturbed area resulting from the installation, removal, and any downstream scour and will monitor the site and control erosion prior to placement of riprap.

13. Department agrees that the installation of such a dam will not adversely affect the water rights of any landowner or district, or of agency.

14. Department will hold agency harmless of and from any loss, injury or expense to Agency or claim or demand from third parties as a result of the installation of the dam.

DEPARTMENT OF WATER RESOURCES

By /s/ Ronald B. Robie

Approved as to legal form
and sufficiency:

/s/ P. A. Towner
P. A. Towner, Chief Counsel
Department of Water Resources

NORTH DELTA WATER AGENCY

By /s/ W. R. Darsie, President

AMENDMENT TO PERMIT

This amendment is made and entered into this 30th day of September, 1976, by and between the Department of Water Resources of the State of California, herein called Department, and North Delta Water Agency, herein called Agency.

RECITALS

(a) Department and Agency entered into a Memorandum of Permit dated August 12, 1976, herein called the permit, under which Department was permitted to install a temporary rock dam, herein called the dam, across Sutter Slough immediately upstream from Sutter Island Upper Cross Road.

(b) Subsequent to the execution of the permit, Department installed the dam in the manner prescribed in the permit and has performed the monitoring and met the standards called for in the permit. Department has determined that the assurances as to quality in paragraphs 6 and 7 of the permit can be maintained with a lesser flow than that required in paragraph 10 of the permit. It has also determined that a lesser flow will not adversely affect the water supply available to diverters downstream from the dam in view of the provisions made by Department for standby capability in the event of such adverse effects, and in view of the reduced demand for irrigation water to be anticipated from the date of this amendment to the removal of the dam.

(c) Agency recognizes the desire of Department to preserve as far as possible the water presently remaining in storage in the event of a succeeding dry year, and is willing to remove the requirement of minimum flow from paragraph 10 of the permit in return for the assurances hereinafter set forth.

AGREEMENTS

1. The permit is amended as follows:

   (a) Paragraph 10 is deleted;

   (b) Paragraph 12 is amended to delete the first sentence thereof and to insert the following: "Department will commence removal of the dam on or before November 29, 1976, complete the removal of any rock within the channel above a depth of minus ten (-10) feet USGS on or before December 3, 1976, and restore the channel location to its prior condition by December 20, 1976, provided that Department will promptly commence and diligently pursue the removal of the dam and restoration of the channel prior to November 29, 1976 if the flow in the Sacramento River at Sacramento reaches 30,000 cfs and is forecast to continue at or above that flow for at least 72 hours, work to commence on or before the date such flow is reached."

2. Except as herein amended the permit shall remain in full force and effect, including all assurances as to the maintenance of water quality during the period of installation of the dam.

DEPARTMENT OF WATER RESOURCES

By /s/ Ronald B. Robie
Ronald B. Robie, Director

Approved as to legal form and sufficiency:

/s/ P. A. Towner
P. A. Towner, Chief Counsel
Department of Water Resources

NORTH DELTA WATER AGENCY

By /s/ W. R. Darsie, President
W. R. Darsie, President

Approved as to legal form and sufficiency:

/s/ George Basye
George Basye, Attorney for
North Delta Water Agency

Addendum 4

WATER QUALITY CONDITIONS AT SELECTED DELTA LOCATIONS DURING 1976

Addendum 4
WATER QUALITY CONDITIONS AT SELECTED
DELTA LOCATIONS DURING 1976
-- January --

Day	Little Potato Slough @ Terminous		Sacramento River @ Rio Vista		San Joaquin River @ San Andreas Landing		Old River @ Clifton Court		Sacramento River @ Green's Landing		Sacramento River @ Emmaton		San Joaquin River @ Jersey Point		San Joaquin River @ Blind Point		Contra Costa Canal @ Rock Slough		San Joaquin River @ Antioch				Sacramento River @ Chipps Island		Suisun Bay @ Port Chicago
	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	Cl md	Cl 14 dm	Cl md	Cl 14 dm	Cl Daily Max.	EC 14 dm	Cl md	TDS md	TDS md	TDS 14 dm	EC md	EC 14 dm	Cl md	Cl 14 dm	TDS Daily Max.
1	110	106	101	98	95	90	152	145	99	95	9	9	10	8	2	0.15	25	158	141	129	0.22	0.19	NR	NR	8640
2	109	107	102	98	95	90	151	146	97	96	9	9	9	8	0	0.16	26	161	143	130	0.22	0.20	NR	NR	8288
3	111	107	102	99	97	91	154	146	97	96	9	9	9	8	1	0.16	27	165	150	132	0.23	0.20	NR	NR	8000
4	110	108	102	99	96	92	154	147	99	96	9	9	9	9	2	0.16	27	163	157	134	0.24	0.20	NR	NR	7360
5	109	108	102	100	95	92	161	146	99	97	10	9	10	9	2	0.16	26	161	166	136	0.26	0.21	NR	NR	7360
6	111	109	102	100	96	93	157	147	102	97	10	9	10	9	1	0.16	28	170	162	139	0.25	0.21	NR	NR	6464
7	114	110	103	100	97	93	158	149	100	98	9	9	10	9	0	0.16	29	174	154	141	0.24	0.22	NR	NR	7040
8	112	110	104	101	97	94	162	150	97	98	10	9	10	9	2	0.17	28	170	152	143	0.24	0.22	NR	NR	9920
9	114	110	103	101	98	94	163	151	102	98	10	9	10	9	9	0.17	26	164	158	146	0.25	0.23	NR	NR	12480
10	119	111	103	102	99	95	171	153	100	99	10	9	10	10	4	0.17	27	168	155	149	0.24	0.23	NR	NR	11680
11	119	111	104	102	99	96	176	156	102	99	10	9	10	10	5	0.17	28	170	167	152	0.26	0.24	NR	NR	12032
12	122	113	105	102	100	96	170	159	101	99	10	9	11	10	17	0.17	28	171	191	156	0.31	0.24	NR	NR	13120
13	120	113	105	103	101	97	167	160	105	100	10	10	12	10	25	0.17	29	176	253	164	0.42	0.26	NR	NR	13120
14	116	114	106	103	102	98	165	162	102	100	11	10	13	10	42	0.17	30	177	304	175	0.51	0.28	NR	NR	12640
15	116	114	107	104	102	98	164	162	99	100	12	10	13	11	56	0.18	30	179	339	189	0.57	0.30	NR	NR	12000
16	118	115	108	104	103	99	171	164	102	100	12	10	13	11	71	0.18	29	176	383	206	0.65	0.33	NR	NR	11840
17	117	115	108	104	102	99	175	165	103	101	14	10	14	11	96	0.19	29	173	434	227	0.74	0.37	NR	NR	12000
18	116	116	108	105	102	99	167	166	102	101	22	11	16	12	112	0.20	24	157	487	250	0.83	0.41	NR	NR	12672
19	114	116	109	105	102	100	164	166	111	102	17	12	16	12	116	0.21	28	169	504	275	0.87	0.46	NR	NR	11712
20	116	117	110	106	103	100	158	167	113	103	15	12	16	13	55	0.22	28	170	498	298	0.85	0.50	NR	NR	10688
21	116	117	111	106	105	101	167	167	119	104	14	13	15	13	67	0.22	29	175	474	321	0.81	0.54	NR	NR	10256
22	117	117	114	107	108	102	193	169	126	106	14	13	16	13	105	0.23	29	176	479	345	0.82	0.58	NR	NR	10624
23	123	118	117	108	111	103	178	170	129	108	17	13	18	14	150	0.24	31	181	516	370	0.89	0.63	NR	NR	11520
24	127	118	121	109	115	104	163	170	121	110	17	14	22	15	174	0.26	32	187	550	399	0.95	0.68	NR	NR	12032
25	133	119	125	111	119	105	155	168	119	111	17	14	25	16	189	0.27	33	189	579	428	1.00	0.73	NR	NR	12160
26	139	121	128	113	121	107	155	167	119	112	22	15	28	17	194	0.26	33	188	625	459	1.08	0.78	NR	NR	12000
27	137	122	128	114	120	108	173	168	117	113	29	17	30	18	189	0.31	31	182	652	488	1.13	0.84	NR	NR	11968
28	136	123	128	116	120	110	168	168	117	114	49	19	38	20	216	0.33	30	177	768	521	1.34	0.89	NR	NR	12480
29	134	125	130	117	121	111	166	168	117	115	66	23	50	23	255	0.35	29	173	830	556	1.45	0.96	NR	NR	12544
30	133	126	131	119	122	112	157	167	115	116	77	28	59	26	280	0.38	29	174	930	595	1.61	1.03	NR	NR	12800
31	131	127	131	121	123	114	163	166	114	117	85	33	59	29	271	0.41	30	177	969	633	1.67	1.09	NR	NR	12320
Mean	120		112		105		164		108		20		19		87		29	173	402		1		0		10960

NOTES "TDS": Total Dissolved Solids, mg/l
"Cl": Chloride, mg/l
"EC": Electrical Conductivity, milliSiemens
"md": Mean Daily; "14 dm": Mean of 14 Consecutive Days

Addendum 4
WATER QUALITY CONDITIONS AT SELECTED
DELTA LOCATIONS DURING 1976
-- February --

	Little Potato Slough @ Termi-nous		Sacra-mento River @ Rio Vista		San Joaquin River @ San Andreas Landing		Old River @ Clifton Court		Sacra-mento River @ Green's Landing		Sacramento River @ Emmaton		San Joaquin River @ Jersey Point		San Joaquin River @ Blind Point		Contra Costa Canal @ Rock Slough		San Joaquin River @ Antioch				Sacramento River @ Chipps Island		Suisun Bay @ Port Chicago
Day	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	Cl md	Cl 14 dm	Cl md	Cl 14 dm	Cl Daily Max.	EC 14 dm	Cl md	TDS md	TDS md	TDS 14 dm	EC md	EC 14 dm	Cl md	Cl 14 dm	TDS Daily Max.
1	133	128	134	123	124	115	159	166	111	118	94	38	67	33	281	0.44	31	181	1045	673	1.79	1.16	NR	NR	12480
2	130	129	133	124	124	117	160	165	108	117	108	45	83	38	300	0.47	31	182	1161	720	1.96	1.24	NR	NR	12352
3	128	130	132	126	127	119	154	165	107	117	139	54	111	44	360	0.50	31	183	1322	779	2.21	1.34	NR	NR	14016
4	127	131	131	127	129	120	194	167	107	116	172	65	125	52	433	0.55	29	175	1507	853	2.50	1.46	NR	NR	14592
5	131	132	123	128	122	121	254	171	101	114	78	69	84	57	NR	0.60	32	187	1084	896	1.85	1.53	NR	NR	11264
6	129	132	126	129	116	122	195	173	97	112	71	73	85	62	NR	0.63	34	194	1086	936	1.85	1.60	NR	NR	12800
7	128	132	120	128	116	122	205	176	100	111	74	77	90	67	NR	0.66	35	197	1102	976	1.87	1.66	NR	NR	15072
8	128	132	117	128	119	122	181	177	97	109	83	82	110	73	NR	0.69	36	200	1262	1025	2.12	1.74	NR	NR	16640
9	125	131	122	127	125	122	182	179	97	108	122	89	155	82	NR	0.71	37	205	1634	1097	2.69	1.86	NR	NR	17760
10	122	130	116	127	121	122	185	180	98	106	98	94	115	88	405	0.72	38	211	1515	1158	2.51	1.96	NR	NR	14880
11	121	129	119	126	118	122	184	181	98	105	134	100	107	93	452	0.75	39	214	1436	1206	2.39	2.03	NR	NR	14272
12	118	127	125	126	120	122	230	186	102	104	183	109	115	97	491	0.76	40	217	1519	1255	2.51	2.11	NR	NR	14400
13	119	126	124	125	120	122	255	193	99	103	209	118	115	101	479	0.79	40	217	1617	1304	2.67	2.18	NR	NR	14080
14	119	125	126	125	118	121	281	201	98	101	186	125	108	105	438	0.80	40	218	1521	1344	2.52	2.24	NR	NR	14080
15	117	124	128	122	115	121	253	208	99	101	186	132	104	108	383	0.81	41	219	1478	1375	2.45	2.29	NR	NR	13632
16	117	123	126	122	112	120	228	213	104	100	166	136	93	108	241	0.81	42	226	1323	1386	2.21	2.31	NR	NR	12800
17	119	123	123	121	111	119	222	218	110	101	132	135	86	107	238	0.81	44	231	1169	1375	1.98	2.29	NR	NR	11712
18	117	122	122	120	113	118	213	219	107	101	119	132	82	104	231	0.78	42	226	1130	1348	1.92	2.25	NR	NR	11520
19	119	121	120	120	116	117	209	216	108	101	127	135	95	104	319	0.76	42	226	1237	1359	2.08	2.27	NR	NR	12800
20	123	121	121	120	114	117	207	217	105	102	77	135	73	103	234	0.75	45	234	976	1351	1.68	2.26	NR	NR	12320
21	124	120	121	120	114	117	198	216	108	102	66	135	73	102	235	0.73	44	232	917	1338	1.59	2.24	NR	NR	11904
22	125	120	125	120	117	117	207	218	106	103	74	134	86	101	248	0.72	43	229	986	1318	1.69	2.21	NR	NR	13600
23	126	120	123	121	123	117	207	220	105	103	106	133	110	97	284	0.72	42	226	1150	1284	1.95	2.15	NR	NR	14080
24	127	121	127	121	123	117	214	222	106	104	115	134	113	97	281	0.72	44	233	1201	1261	2.02	2.12	NR	NR	15168
25	128	121	125	122	121	117	202	223	105	104	101	132	102	97	255	0.70	45	237	1117	1239	1.90	2.08	NR	NR	14272
26	126	122	127	122	122	117	203	221	105	105	107	127	105	96	255	0.68	45	236	1149	1212	1.95	2.04	NR	NR	14080
27	124	122	127	122	123	117	198	217	107	105	100	119	107	96	266	0.67	44	233	1176	1181	1.99	1.99	NR	NR	13280
28	123	122	126	122	123	118	193	211	116	107	101	113	116	95	245	0.65	43	227	1202	1158	2.03	1.96	NR	NR	12800
29	123	123	128	124	127	119	186	206	119	108	144	110	159	99	331	0.65	41	219	1467	1157	2.43	1.96	NR	NR	14280
Mean	124		125		120		205		104		120		103		320		39	214	1258		2		0		13687

NOTES "TDS": Total Dissolved Solids, mg/l
"Cl": Chloride, mg/l
"EC": Electrical Conductivity, milliSiemens
"md": Mean Daily; "14 dm": Mean of 14 Consecutive Days

Addendum 4
WATER QUALITY CONDITIONS AT SELECTED
DELTA LOCATIONS DURING 1976
-- March --

	Little Potato Slough @ Terminous		Sacramento River @ Rio Vista		San Joaquin River @ San Andreas Landing		Old River @ Clifton Court		Sacramento River @ Green's Landing		Sacramento River @ Emmaton		San Joaquin River @ Jersey Point		San Joaquin River @ Blind Point		Contra Costa Canal @ Rock Slough		San Joaquin River @ Antioch				Sacramento River @ Chipps Island		Suisun Bay @ Port Chicago
Day	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	Cl md	Cl 14 dm	Cl md	Cl 14 dm	Cl Daily Max.	EC 14 dm	Cl md	TDS md	TDS md	TDS 14 dm	EC md	EC 14 dm	Cl md	Cl 14 dm	TDS Daily Max.
1	125	123	119	124	129	120	193	204	116	109	99	105	160	104	289	0.66	38	208	1518	1171	2.51	1.98	NR	NR	12864
2	130	124	122	124	128	121	175	200	110	109	74	101	150	108	256	0.66	39	215	1405	1188	2.34	2.01	NR	NR	13152
3	134	126	121	124	123	122	187	199	88	107	43	95	114	111	217	0.65	40	218	1112	1187	1.89	2.00	NR	NR	11712
4	132	127	111	123	114	122	184	197	85	106	28	88	82	110	160	0.64	42	225	843	1158	1.47	1.96	NR	NR	10880
5	125	127	102	122	103	121	178	195	95	105	22	84	69	109	141	0.63	40	219	728	1141	1.27	1.93	NR	NR	10400
6	111	126	102	120	102	120	185	194	100	105	16	81	65	109	147	0.63	38	208	656	1122	1.14	1.90	NR	NR	9920
7	111	125	105	119	106	119	195	193	99	104	14	76	70	108	162	0.62	38	208	626	1096	1.08	1.85	NR	NR	10464
8	114	124	108	118	111	118	199	192	97	103	16	70	81	106	165	0.61	40	217	601	1057	1.04	1.79	NR	NR	11360
9	117	123	110	117	118	118	194	191	103	103	23	63	96	104	168	0.60	40	217	611	1015	1.06	1.72	NR	NR	11680
10	114	122	110	116	121	118	184	190	105	103	36	59	100	104	170	0.60	36	203	607	979	1.05	1.66	NR	NR	14016
11	117	121	113	115	116	117	172	188	110	103	26	53	80	102	152	0.61	38	208	583	938	1.01	1.59	NR	NR	13024
12	121	121	117	114	113	117	171	186	113	104	27	48	76	100	149	0.60	39	215	577	895	1.00	1.52	NR	NR	12800
13	125	121	120	113	115	116	167	184	117	104	34	43	70	98	154	0.59	38	209	598	852	1.03	1.45	NR	NR	12800
14	125	122	124	113	120	116	174	183	114	104	45	36	77	92	150	0.58	36	201	657	794	1.14	1.36	NR	NR	13280
15	124	121	127	114	123	115	174	182	116	104	43	32	72	86	136	0.56	36	201	647	732	1.12	1.26	NR	NR	12000
16	127	121	130	114	124	115	178	182	114	104	48	30	69	80	131	0.55	38	210	677	680	1.17	1.18	NR	NR	11648
17	130	121	133	115	129	115	173	181	114	106	70	32	93	79	161	0.54	37	207	802	658	1.40	1.14	NR	NR	12480
18	131	121	134	117	134	117	170	180	114	108	88	36	107	80	200	0.55	35	198	938	665	1.62	1.15	NR	NR	13920
19	133	121	140	119	134	119	163	179	113	109	87	41	99	83	131	0.56	36	200	933	680	1.61	1.18	NR	NR	13600
20	133	123	138	122	130	121	167	177	114	110	77	45	88	84	206	0.58	38	209	869	695	1.51	1.20	NR	NR	12480
21	132	124	139	125	134	123	167	175	114	111	89	51	99	86	234	0.59	39	215	917	716	1.59	1.24	NR	NR	12640
22	129	126	139	127	138	125	179	174	113	112	113	58	122	89	285	0.61	39	214	1112	752	1.89	1.30	NR	NR	13056
23	127	126	134	128	141	126	181	173	114	113	147	67	125	91	352	0.64	41	220	1149	791	1.95	1.36	NR	NR	13120
24	128	127	136	130	137	128	186	173	114	114	114	72	121	93	281	0.66	43	227	1164	830	1.97	1.43	NR	NR	12160
25	129	128	131	132	135	129	174	173	115	114	82	76	110	95	309	0.68	44	232	1067	865	1.82	1.49	NR	NR	11008
26	130	129	143	133	131	130	177	174	114	114	88	80	105	97	306	0.70	44	233	1073	900	1.83	1.55	NR	NR	11200
27	131	129	142	135	134	132	177	174	117	114	105	86	120	101	303	0.73	45	237	1184	942	2.00	1.62	NR	NR	11024
28	130	129	136	136	139	133	187	175	115	114	115	91	141	105	362	0.76	46	238	1297	988	2.17	1.69	NR	NR	11360
29	131	130	134	136	135	134	194	177	114	114	99	95	123	109	335	0.79	48	248	1172	1025	1.98	1.75	NR	NR	11520
30	131	130	140	137	132	134	211	179	114	114	124	100	124	113	375	0.82	50	254	1184	1062	2.00	1.81	NR	NR	11680
31	129	130	139	137	139	135	214	182	119	115	151	106	147	117	429	0.85	50	257	1354	1101	2.26	1.87	NR	NR	12320
Mean	126		126		125		182		110		69		102		226		40	218	925		2		0		12115

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"Cl": Chloride, mg/l
"EC": Electrical Conductivity, milliSiemens
"md": Mean Daily; "14 dm": Mean of 14 Consecutive Days

Addendum 4
WATER QUALITY CONDITIONS AT SELECTED
DELTA LOCATIONS DURING 1976
-- April --

	Little Potato Slough @ Terminous		Sacramento River @ Rio Vista		San Joaquin River @ San Andreas Landing		Old River @ Clifton Court		Sacramento River @ Green's Landing		Sacramento River @ Emmaton		San Joaquin River @ Jersey Point		San Joaquin River @ Blind Point		Contra Costa Canal @ Rock Slough		San Joaquin River @ Antioch				Sacramento River @ Chipps Island		Suisun Bay @ Port Chicago
Day	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	Cl md	Cl 14 dm	Cl md	Cl 14 dm	Cl Daily Max.	EC 14 dm	Cl md	TDS md	TDS md	TDS 14 dm	EC md	EC 14 dm	Cl md	Cl 14 dm	TDS Daily Max.
1	124	130	139	138	132	135	204	184	119	115	133	109	130	118	454	0.88	73	259	1254	1123	2.11	1.91	NR	NR	12576
2	121	129	139	138	133	135	197	187	116	115	156	114	125	120	316	0.92	75	263	1251	1146	2.10	1.94	NR	NR	12608
3	118	128	141	138	137	135	216	190	114	115	189	122	145	124	522	0.95	75	262	1381	1183	2.30	2.00	NR	NR	13600
4	124	127	138	138	136	136	234	195	111	115	174	128	144	127	531	0.99	76	267	1389	1216	2.31	2.05	NR	NR	13280
5	124	127	134	138	134	135	229	199	109	115	170	132	143	129	540	1.01	77	268	1440	1240	2.39	2.08	NR	NR	13504
6	121	126	133	137	133	135	215	201	110	114	171	134	148	130	557	1.03	75	264	1471	1263	2.44	2.12	NR	NR	13600
7	124	126	127	137	132	134	196	202	109	114	185	139	154	133	500	1.05	74	262	1547	1290	2.56	2.16	NR	NR	13920
8	121	126	123	136	126	134	257	208	108	113	168	145	142	135	466	1.08	73	259	1500	1321	2.48	2.21	NR	NR	12864
9	121	125	123	135	120	133	296	216	108	113	96	145	101	135	355	1.08	75	262	1212	1331	2.04	2.23	NR	NR	11360
10	121	124	123	134	120	132	286	224	111	113	100	145	100	133	346	1.08	78	271	1112	1326	1.89	2.22	NR	NR	12320
11	118	123	123	133	118	130	258	229	110	112	65	142	76	129	274	1.06	79	274	933	1300	1.61	2.18	NR	NR	11040
12	118	123	120	132	118	129	295	236	107	112	50	138	66	125	254	1.04	78	271	827	1275	1.44	2.14	NR	NR	10880
13	118	122	122	130	119	128	265	240	108	111	45	132	62	120	236	1.02	77	267	791	1247	1.38	2.09	NR	NR	10880
14	118	121	123	129	116	127	214	240	108	111	44	125	57	114	249	0.99	76	265	736	1203	1.28	2.02	NR	NR	12480
15	112	120	124	128	117	126	205	240	111	110	57	119	67	109	254	0.96	73	259	801	1171	1.40	1.97	NR	NR	12640
16	112	119	125	127	114	124	240	243	114	110	37	111	56	104	245	0.93	71	254	640	1127	1.11	1.90	NR	NR	11104
17	112	119	125	126	115	123	262	247	111	110	42	100	43	97	209	0.88	73	258	616	1073	1.07	1.81	NR	NR	11200
18	112	118	127	125	117	121	220	246	110	110	64	92	44	90	210	0.83	71	253	620	1018	1.07	1.73	NR	NR	11872
19	118	118	127	125	118	120	190	243	107	109	62	85	38	82	187	0.78	72	255	605	958	1.04	1.63	NR	NR	11200
20	118	117	127	124	118	119	207	242	107	109	65	77	37	75	156	0.73	69	249	587	895	1.01	1.53	NR	NR	10240
21	115	117	126	124	118	118	180	241	108	109	72	69	43	67	182	0.67	65	238	649	831	1.12	1.42	NR	NR	10560
22	112	116	126	124	119	118	182	236	110	109	76	63	53	60	182	0.62	60	227	706	774	1.23	1.33	NR	NR	11200
23	112	115	124	124	115	117	184	228	110	109	60	60	46	56	196	0.59	62	231	680	736	1.18	1.27	NR	NR	11264
24	115	115	123	124	116	117	184	220	111	109	60	57	47	53	205	0.57	59	223	689	706	1.19	1.22	NR	NR	11200
25	118	115	125	124	116	117	184	215	109	109	61	57	48	51	214	0.55	55	214	667	687	1.16	1.19	NR	NR	11680
26	118	115	124	125	118	117	183	207	100	109	39	56	49	49	187	0.54	57	218	607	671	1.05	1.16	NR	NR	10880
27	115	115	127	125	118	117	173	201	103	108	58	57	56	49	223	0.53	56	216	757	669	1.32	1.16	NR	NR	12032
28	112	114	129	126	123	117	181	198	107	108	89	60	74	50	261	0.53	55	213	919	682	1.59	1.18	NR	NR	14720
29	112	114	129	126	118	117	188	197	106	108	104	64	66	50	315	0.54	52	206	914	690	1.58	1.19	NR	NR	14720
30	112	114	129	126	118	118	193	194	105	107	76	66	65	51	323	0.55	56	217	921	710	1.59	1.23	NR	NR	13760
Mean	117		128		122		217		109		92		81		305		69	248	941		2		0		12173

NOTES "TDS": Total Dissolved Solids, mg/l
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"md": Mean Daily; "14 dm": Mean of 14 Consecutive Days

Addendum 4
WATER QUALITY CONDITIONS AT SELECTED
DELTA LOCATIONS DURING 1976
-- May --

	Little Potato Slough @ Terminous		Sacramento River @ Rio Vista		San Joaquin River @ San Andreas Landing		Old River @ Clifton Court		Sacramento River @ Green's Landing		Sacramento River @ Emmaton		San Joaquin River @ Jersey Point		San Joaquin River @ Blind Point		Contra Costa Canal @ Rock Slough		San Joaquin River @ Antioch				Sacramento River @ Chipps Island		Suisun Bay @ Port Chicago
Day	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	Cl md	Cl 14 dm	Cl md	Cl 14 dm	Cl Daily Max.	EC 14 dm	Cl md	TDS md	TDS md	TDS 14 dm	EC md	EC 14 dm	Cl md	Cl 14 dm	TDS Daily Max.
1	109	114	130	127	121	118	192	189	107	107	123	72	78	53	350	0.56	52	207	1082	743	1.84	1.28	NR	NR	13920
2	112	114	130	127	120	119	207	188	108	107	124	77	83	56	358	0.58	51	205	1104	778	1.88	1.34	NR	NR	14240
3	112	114	134	127	121	119	215	189	110	107	125	81	92	60	374	0.60	50	202	1186	819	2.00	1.41	NR	NR	14240
4	112	113	133	128	120	119	203	189	112	108	157	88	100	64	408	0.63	49	198	1321	872	2.21	1.50	NR	NR	14784
5	121	114	133	128	123	119	218	192	111	108	168	94	104	69	416	0.66	49	198	1322	920	2.21	1.57	NR	NR	12861
6	121	114	128	128	122	120	231	195	112	108	119	97	89	71	323	0.68	51	203	1193	954	2.01	1.63	NR	NR	13280
7	121	115	127	129	120	120	185	195	115	108	135	103	89	74	355	0.70	53	210	1254	995	2.11	1.70	NR	NR	12320
8	124	116	128	129	123	121	157	193	118	109	152	109	105	78	391	0.74	51	204	1422	1048	2.36	1.78	2666	243	13120
9	124	116	128	129	127	121	152	191	136	111	152	116	115	83	510	0.78	50	202	1441	1103	2.39	1.87	2727	434	13760
10	121	116	131	130	125	122	161	190	139	114	166	125	122	88	520	0.81	50	202	1450	1163	2.41	1.97	2740	627	13760
11	124	117	135	130	126	122	185	191	127	115	156	132	122	93	536	0.84	53	209	1383	1208	2.31	2.04	2606	810	15360
12	127	118	143	131	132	123	168	190	127	117	183	139	121	97	537	0.87	56	217	1444	1245	2.40	2.09	2801	1006	10880
13	142	120	156	133	139	124	158	187	133	119	238	148	120	100	686	0.90	55	213	1505	1288	2.49	2.16	3310	1238	9261
14	142	122	179	137	148	127	158	185	145	121	315	165	213	111	NR	0.96	55	215	2068	1370	3.36	2.28	3655	1495	9261
15	142	125	190	141	155	129	184	184	148	124	327	180	231	122	900	1.03	57	219	2190	1449	3.55	2.41	3604	1749	9120
16	145	127	208	147	171	132	178	182	142	127	439	202	288	136	907	1.11	57	218	2469	1546	3.98	2.56	4227	2046	9408
17	142	129	205	152	162	135	212	182	145	129	388	221	250	148	827	1.17	58	222	2408	1634	3.88	2.69	3476	2291	8864
18	136	131	201	157	162	138	239	185	154	132	370	236	231	157	700	1.21	63	233	2263	1701	3.66	2.79	3500	2536	NR
19	133	132	190	161	158	141	246	187	154	136	325	248	211	165	517	1.24	67	243	2174	1762	3.52	2.89	3335	2770	NR
20	118	132	184	165	162	144	207	185	148	138	264	258	197	173	512	1.27	72	255	2024	1821	3.29	2.98	3048	2983	NR
21	118	131	177	168	169	147	177	184	136	140	298	270	227	182	581	1.32	71	252	2259	1893	3.65	3.09	3365	3219	NR
22	118	131	178	172	168	150	166	185	151	142	312	281	224	191	833	1.36	74	259	2216	1950	3.59	3.18	3119	3251	NR
23	118	131	179	176	167	153	180	187	154	143	326	294	222	198	799	1.38	77	266	2172	2002	3.52	3.26	3019	3272	NR
24	118	130	179	179	165	156	204	190	157	145	284	302	219	205	813	1.41	80	273	2129	2050	3.45	3.33	3013	3291	NR
25	115	130	180	182	164	159	205	192	154	147	242	308	216	212	779	1.45	82	281	2085	2101	3.39	3.41	3036	3322	NR
26	115	129	181	185	172	162	196	194	157	149	267	314	228	220	751	1.48	85	288	2176	2153	3.53	3.49	3188	3350	NR
27	121	127	183	187	184	165	204	197	163	151	330	321	278	231	953	1.52	84	285	2401	2217	3.87	3.59	3490	3363	15360
28	124	126	185	187	188	168	248	203	167	152	329	322	275	235	926	1.54	86	291	2300	2233	3.72	3.61	3370	3342	15680
29	121	125	203	188	189	170	263	209	157	153	318	321	265	238	912	1.55	88	296	2337	2244	3.77	3.63	3384	3327	15520
30	121	123	209	188	196	172	249	214	154	154	396	318	299	239	941	1.55	89	298	2570	2251	4.13	3.64	3484	3273	16512
31	124	121	208	188	183	173	253	217	145	154	336	314	253	239	831	1.56	91	302	2128	2231	3.45	3.61	3307	3261	16000
Mean	124		166		151		200		138		254		183		642		65	238	1854		3		3228		13069

NOTES "TDS": Total Dissolved Solids, mg/l
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"EC": Electrical Conductivity, milliSiemens
"md": Mean Daily; "14 dm": Mean of 14 Consecutive Days

Addendum 4
WATER QUALITY CONDITIONS AT SELECTED
DELTA LOCATIONS DURING 1976
-- June --

	Little Potato Slough @ Termi-nous		Sacra-mento River @ Rio Vista		San Joaquin River @ San Andreas Landing		Old River @ Clifton Court		Sacra-mento River @ Green's Landing		Sacramento River @ Emmaton		San Joaquin River @ Jersey Point		San Joaquin River @ Blind Point		Contra Costa Canal @ Rock Slough		San Joaquin River @ Antioch				Sacramento River @ Chipps Island		Suisun Bay @ Port Chicago
Day	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	Cl md	Cl 14 dm	Cl md	Cl 14 dm	Cl Daily Max.	EC 14 dm	Cl md	TDS md	TDS md	TDS 14 dm	EC md	EC 14 dm	Cl md	Cl 14 dm	TDS Daily Max.
1	124	121	204	189	185	175	249	218	139	153	329	311	247	240	773	1.57	99	304	2241	2229	3.62	3.61	3249	3243	16160
2	124	120	202	189	180	177	238	217	142	152	317	310	237	242	715	1.60	100	306	2180	2230	3.53	3.61	3212	3235	14592
3	133	121	197	190	171	177	240	220	142	152	296	313	226	244	637	1.61	113	330	2122	2237	3.44	3.62	3005	3232	16192
4	136	122	188	191	165	177	242	224	145	152	266	310	200	242	630	1.60	114	332	1966	2216	3.20	3.59	2939	3201	15232
5	133	123	175	191	165	177	256	231	148	152	257	306	206	241	630	1.59	115	334	1912	2194	3.12	3.55	2872	3184	15424
6	136	125	169	190	165	177	235	235	142	151	242	300	202	239	686	1.58	115	334	1908	2175	3.11	3.52	2872	3173	16000
7	136	126	174	190	166	177	233	237	136	150	283	300	218	239	793	1.58	116	335	2070	2171	3.36	3.52	3138	3182	16192
8	142	128	183	190	165	177	227	238	136	148	275	303	232	240	893	1.59	112	327	2125	2174	3.45	3.52	3105	3187	16800
9	136	129	186	190	174	177	215	240	133	147	309	306	255	242	865	1.60	109	323	2256	2180	3.65	3.53	3435	3204	17920
10	130	130	196	191	173	176	251	243	130	144	356	308	275	242	1028	1.60	107	319	2408	2180	3.88	3.53	3361	3195	17920
11	130	131	208	193	171	175	246	243	133	142	395	312	296	244	1098	1.61	107	318	2483	2193	4.00	3.55	3510	3205	NR
12	130	131	212	194	174	174	262	243	130	140	385	317	290	246	1070	1.61	109	322	2464	2202	3.97	3.57	3510	3214	NR
13	133	132	212	194	183	173	256	243	136	139	390	317	289	245	997	1.61	109	323	2395	2190	3.86	3.55	3435	3211	NR
14	130	133	213	194	184	173	253	243	142	138	342	317	264	246	827	1.61	109	323	2211	2196	3.58	3.56	3323	3212	NR
15	130	133	207	194	172	172	253	243	136	138	413	323	283	248	796	1.63	109	323	2348	2203	3.79	3.57	3212	3209	NR
16	130	133	213	195	184	172	260	245	136	138	435	332	317	254	842	1.65	109	322	2538	2229	4.08	3.61	3510	3230	16640
17	142	134	218	197	188	174	248	246	130	137	439	342	334	262	799	1.69	112	327	2592	2263	4.17	3.66	3733	3282	15424
18	139	134	205	198	200	176	248	246	124	135	498	359	326	271	819	1.73	112	328	2709	2316	4.34	3.74	3808	3344	15616
19	139	135	197	199	181	177	242	245	124	134	369	367	278	276	884	1.76	113	329	2382	2349	3.84	3.79	3472	3387	15200
20	142	135	193	201	187	179	250	246	124	132	362	375	284	282	856	1.79	112	327	2476	2390	3.99	3.85	3472	3430	15200
21	136	135	179	201	174	179	254	247	115	131	362	381	272	285	922	1.81	112	328	2328	2408	3.76	3.88	3249	3438	16000
22	139	135	175	201	174	180	303	253	109	129	300	383	252	287	865	1.81	114	332	2219	2415	3.59	3.89	3174	3443	16000
23	130	134	174	200	174	180	294	259	109	127	290	381	245	286	816	1.80	116	335	2075	2402	3.37	3.87	3138	3422	NR
24	133	135	179	199	179	180	291	261	109	126	312	378	255	285	744	1.78	117	337	2122	2382	3.44	3.84	3398	3425	NR
25	136	135	196	198	185	181	256	262	109	124	426	380	301	285	1017	1.77	118	339	2540	2386	4.09	3.85	3621	3432	16640
26	130	135	230	199	193	183	274	263	106	122	482	387	334	288	1210	1.78	120	343	2646	2399	4.25	3.87	3957	3464	17024
27	127	135	238	201	193	183	282	265	103	120	583	401	341	292	1225	1.79	122	347	2752	2424	4.41	3.91	4031	3507	17280
28	133	135	254	204	194	184	286	267	100	117	599	419	377	300	1239	1.84	121	346	2819	2468	4.51	3.97	4329	3579	16800
29	124	134	273	209	204	186	277	269	112	115	657	437	425	310	1199	1.88	120	343	2964	2512	4.74	4.04	4553	3675	17408
30	124	134	245	211	189	187	262	269	112	113	627	451	380	315	1064	1.90	120	342	3069	2550	4.90	4.10	4292	3731	17216
Mean	133		203		180		256		126		387		281		898		113	329	2377		4		3464		16299

NOTES "TDS": Total Dissolved Solids, mg/l
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"EC": Electrical Conductivity, milliSiemens
"md": Mean Daily; "14 dm": Mean of 14 Consecutive Days

Addendum 4
WATER QUALITY CONDITIONS AT SELECTED
DELTA LOCATIONS DURING 1976
-- July --

	Little Potato Slough @ Terminous		Sacramento River @ Rio Vista		San Joaquin River @ San Andreas Landing		Old River @ Clifton Court		Sacramento River @ Green's Landing		Sacramento River @ Emmaton		San Joaquin River @ Jersey Point		San Joaquin River @ Blind Point		Contra Costa Canal @ Rock Slough		San Joaquin River @ Antioch				Sacramento River @ Chipps Island		Suisun Bay @ Port Chicago
Day	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	Cl md	Cl 14 dm	Cl md	Cl 14 dm	Cl Daily Max.	EC 14 dm	Cl md	TDS md	TDS md	TDS 14 dm	EC md	EC 14 dm	Cl md	Cl 14 dm	TDS Daily Max.
1	130	133	226	212	162	185	294	272	118	112	499	455	310	313	865	1.89	118	339	2668	2555	4.28	4.11	3808	3736	15680
2	118	132	227	213	167	183	304	276	118	112	503	455	300	311	847	1.88	117	338	2822	2563	4.52	4.12	3770	3733	15104
3	121	130	206	214	160	181	296	280	112	111	473	463	285	311	779	1.88	117	336	2758	2590	4.42	4.16	3584	3741	15360
4	124	129	193	214	154	179	299	284	109	110	431	468	269	310	856	1.87	115	334	2694	2606	4.32	4.19	3435	3739	15936
5	121	128	186	214	155	177	301	287	109	110	382	469	269	310	884	1.86	117	337	2629	2627	4.22	4.22	3398	3749	16000
6	124	127	189	215	159	176	287	286	109	110	427	478	293	313	979	1.88	118	340	2565	2652	4.12	4.26	3472	3770	NR
7	121	126	194	217	172	176	273	284	112	110	491	492	337	320	1103	1.91	119	341	2501	2682	4.03	4.30	3696	3810	NR
8	118	125	203	219	176	176	282	284	112	110	501	506	439	333	1170	1.95	118	339	2911	2739	4.66	4.39	3770	3837	NR
9	118	124	225	221	186	176	290	286	115	110	523	513	374	338	1225	1.97	123	348	2899	2764	4.64	4.43	4069	3869	NR
10	118	123	231	221	179	175	284	287	115	111	543	517	376	341	1253	1.98	129	359	2937	2785	4.70	4.46	4218	3888	NR
11	118	122	243	221	187	174	273	286	118	112	595	518	382	344	1225	2.00	135	371	3094	2809	4.94	4.50	4255	3903	NR
12	121	121	223	219	181	174	278	286	109	113	532	513	328	341	1087	1.98	142	383	2942	2818	4.70	4.51	3919	3874	NR
13	121	121	215	215	169	171	273	285	106	112	473	500	319	333	1004	1.94	134	368	2768	2804	4.44	4.49	3770	3818	NR
14	118	121	213	213	180	170	269	286	115	113	483	490	351	331	958	1.94	129	360	2872	2790	4.60	4.47	4031	3800	NR
15	118	120	196	210	166	171	274	285	112	112	464	487	331	332	875	1.96	125	353	2795	2799	4.48	4.48	3882	3805	15360
16	118	120	174	207	167	171	265	282	112	112	472	485	319	334	771	1.97	115	333	2826	2799	4.52	4.48	3845	3810	14880
17	124	120	161	203	163	171	260	279	112	112	340	476	258	332	799	1.97	124	351	2576	2786	4.14	4.46	3472	3802	NR
18	121	120	149	200	151	171	268	277	114	112	278	465	236	329	779	1.97	123	348	2386	2764	3.85	4.43	3174	3784	NR
19	124	120	137	197	145	170	268	275	117	113	247	455	221	326	858	1.96	125	352	2227	2736	3.60	4.39	3038	3758	NR
20	127	120	131	193	148	169	281	274	119	113	239	442	239	322	902	1.95	140	380	2319	2718	3.74	4.36	3072	3729	NR
21	121	120	128	188	159	168	287	275	122	114	222	422	246	316	931	1.94	138	376	2324	2705	3.75	4.34	3138	3690	16000
22	121	121	136	183	165	168	275	275	124	115	228	403	276	304	960	1.92	141	381	2416	2670	3.89	4.29	3472	3668	16448
23	121	121	143	177	182	167	268	273	125	116	273	385	300	299	1075	1.93	150	399	2551	2645	4.10	4.25	3882	3655	16000
24	124	121	149	171	177	167	261	271	125	116	293	367	307	294	1042	1.91	131	364	2536	2617	4.08	4.20	3621	3612	16000
25	127	122	165	166	183	167	257	270	126	117	303	346	317	289	1056	1.90	131	363	2594	2581	4.17	4.15	3770	3578	NR
26	127	122	171	162	189	167	259	269	123	118	329	332	332	289	1004	1.90	123	349	2713	2565	4.35	4.12	3845	3572	NR
27	127	123	178	159	184	169	263	268	122	119	340	322	323	290	976	1.91	116	334	2694	2559	4.32	4.11	3957	3586	NR
28	130	124	173	157	188	169	248	267	120	120	348	313	323	288	925	1.91	117	337	2692	2546	4.32	4.09	3994	3583	15040
29	130	125	171	155	185	170	257	265	121	120	362	305	317	287	847	1.91	119	340	2661	2537	4.27	4.08	3957	3588	14720
30	133	126	171	155	183	172	240	264	115	120	371	298	313	286	819	1.91	120	343	2717	2529	4.36	4.07	3808	3586	14656
31	130	126	162	155	173	172	238	262	115	121	314	296	296	289	791	1.91	121	344	2596	2530	4.17	4.07	3584	3594	14240
Mean	123		183		171		273		116		396		309		956		125	353	2667		4		3700		15428

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Addendum 4
WATER QUALITY CONDITIONS AT SELECTED
DELTA LOCATIONS DURING 1976
-- August --

	Little Potato Slough @ Terminous		Sacramento River @ Rio Vista		San Joaquin River @ San Andreas Landing		Old River @ Clifton Court		Sacramento River @ Green's Landing		Sacramento River @ Emmaton		San Joaquin River @ Jersey Point		San Joaquin River @ Blind Point		Contra Costa Canal @ Rock Slough		San Joaquin River @ Antioch				Sacramento River @ Chipps Island		Suisun Bay @ Port Chicago
Day	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	Cl md	Cl 14 dm	Cl md	Cl 14 dm	Cl Daily Max.	EC 14 dm	Cl md	TDS md	TDS md	TDS 14 dm	EC md	EC 14 dm	Cl md	Cl 14 dm	TDS Daily Max.
1	133	127	157	155	161	173	248	261	112	121	270	296	249	290	819	1.93	120	344	2448	2535	3.94	4.08	3361	3607	14560
2	136	128	148	156	153	174	268	261	115	120	241	295	239	291	847	1.94	123	348	2350	2544	3.79	4.09	3072	3609	14720
3	124	128	144	157	148	174	274	260	115	120	221	294	228	290	903	1.94	138	376	2215	2536	3.59	4.08	3005	3605	14720
4	121	128	141	158	148	173	285	260	115	120	216	293	225	289	903	1.94	153	404	2225	2526	3.60	4.07	3005	3595	14720
5	124	128	141	158	156	172	291	261	115	119	242	294	243	286	931	1.93	152	402	2298	2521	3.71	4.06	2972	3559	15200
6	127	128	153	159	165	171	289	263	115	118	282	295	265	284	931	1.90	150	400	2447	2513	3.94	4.04	3072	3502	16000
7	130	129	168	160	162	170	283	264	118	118	274	294	250	280	847	1.89	149	396	2289	2496	3.70	4.02	3005	3458	15616
8	127	129	179	161	167	169	273	265	118	117	277	292	250	275	903	1.87	141	382	2324	2476	3.75	3.99	3138	3412	15680
9	133	129	179	162	174	168	278	267	124	117	287	289	253	269	875	1.86	123	349	2345	2450	3.79	3.95	3138	3362	15520
10	136	130	174	162	182	168	263	267	127	118	298	286	264	265	847	1.83	118	339	2351	2426	3.79	3.91	3212	3309	15168
11	142	131	170	161	177	167	253	267	142	119	262	280	247	260	707	1.80	114	331	2234	2393	3.61	3.86	3105	3245	14784
12	151	132	165	161	174	166	259	267	148	121	248	272	218	253	595	1.76	113	329	2107	2353	3.42	3.80	3005	3177	13952
13	151	133	163	160	172	165	248	268	151	124	242	262	207	245	553	1.72	112	328	2032	2304	3.30	3.72	2939	3115	13504
14	160	136	160	160	168	165	250	269	151	126	210	255	192	238	548	1.69	113	329	1971	2260	3.21	3.65	2872	3064	13440
15	157	137	159	160	166	165	242	268	145	129	181	249	179	233	540	1.67	112	327	1914	2222	3.12	3.60	2773	3022	13440
16	167	139	156	161	162	166	231	266	142	131	149	242	169	228	623	1.64	113	329	1777	2181	2.91	3.53	2673	2994	13248
17	170	143	160	162	169	167	221	262	139	132	144	267	190	225	NR	1.62	109	321	1865	2156	3.05	3.49	2773	2977	14784
18	163	146	160	163	166	169	228	258	142	134	131	231	193	223	NR	1.64	106	316	1873	2130	3.06	3.46	2872	2968	14272
19	160	148	165	165	174	170	239	254	130	135	127	222	220	221	735	1.62	104	313	1933	2104	3.15	3.41	3105	2977	15040
20	160	151	175	167	186	171	232	250	124	136	156	213	260	221	791	1.61	101	308	2096	2079	3.40	3.38	3286	2993	14560
21	157	153	183	168	198	174	223	246	124	136	173	206	258	221	819	1.62	103	311	2331	2082	3.76	3.38	3435	3023	14720
22	154	155	179	168	190	175	226	242	124	137	166	198	281	224	847	1.61	103	311	2242	2076	3.63	3.37	3174	3026	14496
23	151	156	176	167	184	176	208	237	124	137	144	188	240	223	749	1.59	102	309	2153	2063	3.49	3.35	2839	3005	13600
24	154	157	174	167	184	176	199	233	124	137	150	177	243	221	679	1.57	102	309	2064	2042	3.35	3.32	2872	2980	13120
25	160	158	175	168	183	172	211	230	145	137	170	171	244	221	648	1.56	100	305	1973	2023	3.21	3.29	2806	2959	12864
26	157	159	176	169	183	167	213	227	142	136	147	164	244	223	540	1.56	102	309	1848	2005	3.02	3.26	2706	2938	12160
27	160	160	177	170	181	168	218	224	145	136	159	158	242	225	512	1.55	106	317	1817	1990	2.97	3.24	2706	2921	11520
28	160	160	179	171	193	170	222	222	142	135	180	156	264	230	595	1.55	105	314	1877	1983	3.07	3.23	2773	2914	11520
29	167	160	178	172	200	172	214	220	148	136	192	156	254	236	679	1.56	102	310	1937	1985	3.16	3.23	2839	2919	13120
30	163	160	173	174	205	175	229	220	139	135	194	160	241	241	693	1.58	102	310	1932	1996	3.15	3.25	2673	2919	12608
31	167	160	172	174	214	179	219	220	133	135	211	164	253	245	707	1.59	104	313	2057	2009	3.34	3.27	2806	2921	12672
Mean	149		166		176		243		132		205		236		737		116	335	2107		3		2963		14043

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Addendum 4
WATER QUALITY CONDITIONS AT SELECTED
DELTA LOCATIONS DURING 1976
-- September --

Day	Little Potato Slough @ Terminous		Sacramento River @ Rio Vista		San Joaquin River @ San Andreas Landing		Old River @ Clifton Court		Sacramento River @ Green's Landing		Sacramento River @ Emmaton		San Joaquin River @ Jersey Point		San Joaquin River @ Blind Point		Contra Costa Canal @ Rock Slough		San Joaquin River @ Antioch				Sacramento River @ Chipps Island		Suisun Bay @ Port Chicago
	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	Cl md	Cl 14 dm	Cl md	Cl 14 dm	Cl Daily Max.	EC 14 dm	Cl md	TDS md	TDS md	TDS 14 dm	EC md	EC 14 dm	Cl md	Cl 14 dm	TDS Daily Max.
1	170	160	174	175	225	183	221	220	133	134	232	172	264	251	833	1.58	104	312	2116	2027	3.43	3.30	3845	2990	NR
2	167	161	172	176	207	185	219	218	130	134	229	179	281	255	869	1.61	101	307	2177	2044	3.53	3.32	3174	2995	NR
3	163	161	168	175	214	187	234	218	133	135	227	184	277	256	855	1.62	100	305	2215	2053	3.58	3.34	3138	2985	NR
4	160	161	183	175	219	189	243	220	136	136	227	188	291	259	819	1.62	102	309	2310	2051	3.73	3.33	3174	2966	13760
5	160	162	197	177	232	192	247	221	136	137	257	194	317	261	791	1.62	104	312	2338	2058	3.77	3.34	3286	2974	13184
6	160	162	197	178	206	193	260	225	136	137	267	203	309	266	780	1.65	106	317	2309	2069	3.73	3.36	3435	3017	14272
7	160	163	191	179	209	195	250	229	139	139	247	210	302	270	791	1.67	112	327	2213	2080	3.58	3.38	3138	3036	14080
8	160	163	199	181	203	201	238	230	136	138	263	217	309	275	721	1.69	117	338	2126	2091	3.45	3.39	3105	3057	12960
9	163	163	201	183	211	208	243	233	136	137	269	225	343	282	743	1.73	117	337	2235	2118	3.62	3.44	3249	3096	12704
10	167	163	195	184	216	211	242	234	142	137	293	235	367	291	819	1.79	117	338	2420	2162	3.90	3.50	3574	3156	13120
11	170	164	191	185	218	213	235	235	145	137	287	243	368	298	819	1.84	122	346	2503	2206	4.03	3.57	3510	3209	13120
12	167	164	171	185	209	213	240	237	142	137	239	246	320	303	777	1.87	122	347	2325	2234	3.75	3.61	3138	3230	12160
13	173	165	171	184	210	214	245	238	145	137	245	249	331	309	847	1.90	123	347	2401	2267	3.87	3.67	3249	3271	13760
14	173	165	170	184	232	215	254	241	148	139	238	251	390	319	958	1.95	122	346	2460	2296	3.96	3.71	3323	3308	14720
15	170	165	173	184	257	217	259	244	148	140	250	253	413	330	1014	1.99	121	345	2752	2342	4.41	3.78	3361	3273	15360
16	160	165	167	184	251	220	267	247	145	141	245	254	397	338	958	2.02	124	349	2625	2374	4.22	3.83	3435	3292	14112
17	167	165	168	184	232	222	284	250	148	142	213	253	370	345	986	2.04	126	354	2503	2394	4.03	3.86	3323	3305	14112
18	173	166	175	183	242	223	273	253	151	143	203	251	376	351	986	2.07	123	347	2427	2403	3.91	3.87	3174	3305	13440
19	173	167	181	182	263	226	285	255	151	144	236	249	405	357	986	2.10	122	347	2577	2420	4.14	3.90	3398	3313	13760
20	173	168	200	182	275	231	300	258	151	145	293	251	425	365	1014	2.13	125	352	2816	2456	4.51	3.96	3621	3326	13920
21	179	169	219	184	253	234	285	261	148	146	279	254	388	372	958	2.16	150	398	2733	2493	4.38	4.01	3547	3356	13440
22	176	170	235	187	243	237	303	265	142	146	338	259	389	377	875	2.18	159	415	2549	2523	4.10	4.06	3621	3393	14336
23	173	171	242	190	240	239	280	268	148	147	382	267	384	380	833	2.20	157	412	2555	2546	4.11	4.09	3696	3425	13888
24	173	171	255	194	244	241	305	272	145	147	420	276	380	381	903	2.20	156	411	2649	2563	4.25	4.12	3882	3448	13984
25	171	171	250	198	253	243	283	276	133	146	474	290	405	384	931	2.21	158	413	2833	2586	4.54	4.16	3957	3480	13984
26	170	171	254	204	242	246	313	281	130	146	487	307	392	389	1000	2.23	158	414	2830	2622	4.53	4.21	3957	3539	14720
27	170	171	246	210	230	247	301	285	121	144	474	324	362	391	1012	2.23	158	414	2733	2646	4.38	4.25	3770	3576	14336
28	167	171	257	216	228	247	313	289	130	142	500	342	374	390	961	2.22	158	414	2774	2668	4.45	4.28	4031	3627	13888
29	160	170	239	221	217	244	323	294	118	140	541	363	378	387	919	2.18	159	416	2754	2668	4.41	4.28	3808	3659	12960
30	151	169	246	226	218	241	304	296	115	138	568	386	364	385	970	2.16	159	416	2772	2679	4.44	4.30	3808	3685	13120
Mean	167		203		230		268		139		314		356		891		129	360	2501		4		3491		13748

NOTES "TDS": Total Dissolved Solids, mg/l
"Cl": Chloride, mg/l
"EC": Electrical Conductivity, milliSiemens
"md": Mean Daily; "14 dm": Mean of 14 Consecutive Days

Addendum 4
WATER QUALITY CONDITIONS AT SELECTED
DELTA LOCATIONS DURING 1976
-- October --

	Little Potato Slough @ Terminous		Sacramento River @ Rio Vista		San Joaquin River @ San Andreas Landing		Old River @ Clifton Court		Sacramento River @ Green's Landing		Sacramento River @ Emmaton		San Joaquin River @ Jersey Point		San Joaquin River @ Blind Point		Contra Costa Canal @ Rock Slough		San Joaquin River @ Antioch				Sacramento River @ Chipps Island		Suisun Bay @ Port Chicago
Day	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	Cl md	Cl 14 dm	Cl md	Cl 14 dm	Cl Daily Max.	EC 14 dm	Cl md	TDS md	TDS md	TDS 14 dm	EC md	EC 14 dm	Cl md	Cl 14 dm	TDS Daily Max.
1	148	168	225	230	213	238	309	298	118	136	518	408	367	385	844	2.15	155	408	2633	2688	4.23	4.31	3808	3720	NR
2	145	166	202	232	190	233	310	301	115	133	441	425	327	381	841	2.12	153	404	2376	2685	3.83	4.31	3547	3746	NR
3	142	164	210	234	188	227	308	303	118	131	428	439	298	374	738	2.07	156	411	2402	2672	3.87	4.29	3398	3746	NR
4	136	161	209	235	176	221	315	304	118	129	434	449	313	366	727	2.02	156	410	2376	2641	3.83	4.24	3435	3733	NR
5	136	158	211	234	162	216	290	304	124	127	471	463	309	360	704	1.98	162	421	2066	2593	3.36	4.17	3472	3728	NR
6	136	156	219	233	165	210	282	303	121	125	475	472	322	355	718	1.95	158	413	2168	2566	3.51	4.12	3547	3723	NR
7	136	153	217	231	172	205	293	304	112	123	513	482	324	351	769	1.92	149	398	2160	2538	3.50	4.08	3733	3725	NR
8	142	151	213	228	172	199	307	304	112	120	531	490	311	346	668	1.89	145	384	2103	2499	3.41	4.02	3696	3712	14080
9	145	149	236	227	172	194	299	305	115	119	551	495	292	338	794	1.85	154	405	2227	2455	3.60	3.95	3733	3696	14080
10	142	147	242	227	179	191	275	302	112	118	556	500	357	336	858	1.83	143	405	2334	2420	3.77	3.90	3957	3696	15040
11	142	145	226	225	173	187	297	302	112	117	584	508	340	334	841	1.80	150	399	2345	2392	3.79	3.86	3882	3704	14720
12	142	143	218	222	169	183	298	301	112	116	577	513	297	328	822	1.79	152	402	2295	2358	3.71	3.81	3659	3677	14944
13	136	142	223	221	166	180	284	298	112	115	626	519	318	324	945	1.78	153	405	2323	2327	3.75	3.76	3696	3669	NR
14	136	141	253	222	179	177	271	296	109	115	664	526	356	324	1031	1.79	138	376	2490	2307	4.01	3.73	3994	3683	NR
15	130	139	239	223	176	174	270	293	109	114	662	537	368	324	995	1.80	138	376	2586	2304	4.16	3.72	4031	3699	NR
16	130	138	234	225	170	173	277	291	112	114	617	549	329	324	931	1.82	138	376	2525	2314	4.06	3.74	3882	3723	NR
17	133	137	243	227	167	171	293	289	109	113	699	568	333	326	1003	1.84	138	376	2618	2330	4.21	3.76	3957	3762	14720
18	133	137	251	230	179	172	271	286	106	113	799	595	369	330	1014	1.88	138	376	2829	2362	4.53	3.81	4218	3818	NR
19	136	137	259	234	171	172	298	287	103	111	765	616	343	333	986	1.90	138	376	2744	2410	4.40	3.89	4031	3858	14976
20	136	137	290	239	171	173	351	292	109	110	744	635	304	331	900	1.95	138	375	2653	2445	4.26	3.94	4031	3893	15680
21	136	137	315	246	166	172	351	296	109	110	781	654	327	332	1081	1.98	135	371	2764	2488	4.43	4.01	4292	3933	16000
22	133	137	322	254	173	172	343	299	97	109	821	675	360	335	1213	2.02	135	371	2892	2545	4.63	4.09	4441	3986	16960
23	133	136	372	263	179	173	323	300	100	108	876	698	406	343	1232	2.07	136	372	2907	2593	4.65	4.17	4627	4050	17440
24	130	135	311	268	174	172	327	304	94	107	845	718	393	346	1229	2.10	138	377	2781	2625	4.46	4.22	4441	4084	17120
25	133	134	286	273	163	172	309	305	103	106	744	730	310	344	1012	2.11	143	386	2506	2637	4.03	4.23	4143	4103	16480
26	127	133	291	278	162	171	310	306	94	105	566	729	288	343	883	2.11	146	392	2202	2630	3.56	4.22	3994	4127	15520
27	127	133	273	281	162	171	329	309	97	104	711	735	305	342	992	2.12	152	403	2219	2622	3.59	4.21	3845	4138	15744
28	118	131	310	285	162	170	307	311	106	103	719	739	311	339	964	2.12	146	391	2434	2618	3.92	4.21	3957	4135	15520
29	118	130	279	288	154	168	330	316	112	104	664	739	326	336	864	2.11	150	398	2402	2605	3.87	4.19	3882	4124	14720
30	112	129	250	289	146	167	333	320	124	104	605	738	305	334	693	2.09	154	407	2211	2583	3.58	4.15	3733	4114	13760
31	118	128	217	288	141	165	317	321	112	105	546	727	257	329	690	2.07	160	417	2040	2542	3.32	4.09	3435	4076	13760
Mean	134		253		171		306		110		630		328		903		147	393	2439		4		3887		15330

NOTES "TDS": Total Dissolved Solids, mg/l
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"md": Mean Daily; "14 dm": Mean of 14 Consecutive Days

Addendum 4
WATER QUALITY CONDITIONS AT SELECTED
DELTA LOCATIONS DURING 1976
-- November --

	Little Potato Slough @ Terminous		Sacramento River @ Rio Vista		San Joaquin River @ San Andreas Landing		Old River @ Clifton Court		Sacramento River @ Green's Landing		Sacramento River @ Emmaton		San Joaquin River @ Jersey Point		San Joaquin River @ Blind Point		Contra Costa Canal @ Rock Slough		San Joaquin River @ Antioch				Sacramento River @ Chipps Island		Suisun Bay @ Port Chicago
Day	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	Cl md	Cl 14 dm	Cl md	Cl 14 dm	Cl Daily Max.	EC 14 dm	Cl md	TDS md	TDS md	TDS 14 dm	EC md	EC 14 dm	Cl md	Cl 14 dm	TDS Daily Max.
1	118	127	202	284	140	162	322	325	103	104	517	707	240	320	674	2.02	160	417	1938	2478	3.16	3.99	3323	4013	14080
2	118	126	250	283	145	160	301	325	106	105	528	690	252	313	743	1.99	154	406	2016	2426	3.28	3.91	3510	3975	14560
3	127	125	256	281	146	158	312	322	112	105	562	677	265	310	735	1.94	150	398	2031	2385	3.38	3.85	3659	3949	14880
4	121	124	262	277	151	157	300	319	115	105	602	665	293	308	852	1.92	143	386	2308	2353	3.73	3.80	3882	3919	15200
5	118	123	291	275	167	157	299	316	112	106	684	655	332	306	1028	1.89	138	376	2688	2338	4.31	3.77	4292	3909	15840
6	118	122	316	271	169	156	289	313	115	107	798	649	400	305	1126	1.88	135	372	2883	2336	4.61	3.77	4478	3898	16448
7	118	121	335	273	173	156	281	310	115	109	828	648	403	306	1134	1.89	133	366	2911	2346	4.66	3.79	4441	3898	16000
8	121	120	323	275	168	156	282	308	112	110	858	656	342	309	1160	1.91	131	363	2827	2368	4.53	3.82	4367	3914	16192
9	130	120	380	282	181	158	269	305	112	111	889	679	352	313	1313	1.96	129	359	2900	2418	4.64	3.90	4553	3954	16800
10	130	120	374	289	181	159	283	302	124	113	920	694	381	319	1383	2.01	126	354	3009	2475	4.81	3.98	4702	4015	16480
11	133	121	397	295	193	161	303	302	124	114	946	710	394	324	1383	2.06	124	351	3164	2527	5.05	4.07	4776	4074	16640
12	133	123	421	305	185	163	282	298	124	115	955	731	398	330	1350	2.12	126	353	3118	2578	4.97	4.14	4702	4132	16320
13	136	124	286	308	165	165	283	295	124	115	974	758	370	334	1095	2.17	126	355	2931	2630	4.69	4.22	4367	4178	14880
14	136	126	250	310	166	167	304	294	124	116	951	787	356	341	1084	2.23	128	358	2882	2690	4.61	4.32	4180	4231	15072
15	136	127	246	313	145	167	293	292	124	117	853	811	309	346	917	2.26	131	364	2457	2727	3.96	4.37	3919	4273	14080
16	139	128	280	316	144	167	288	291	124	119	782	829	307	350	961	2.28	133	367	2402	2754	3.87	4.41	3808	4295	15795
17	133	129	264	316	145	167	298	290	130	120	738	841	291	352	1042	2.31	134	370	2378	2776	3.84	4.45	3770	4303	16180
18	130	129	275	317	150	167	296	289	133	121	797	855	312	353	1227	2.34	136	372	2451	2786	3.95	4.46	4031	4313	16950
19	130	130	318	319	172	167	296	289	136	123	868	868	329	353	1274	2.37	136	372	2561	2777	4.12	4.45	4180	4305	17825
20	136	132	360	322	172	167	297	290	130	124	891	875	351	350	1391	2.39	135	370	2588	2756	4.16	4.42	4367	4297	18000
21	136	133	409	328	181	168	304	291	142	126	883	879	378	348	1470	2.42	133	368	2555	2730	4.11	4.38	4516	4303	18350
22	136	134	439	336	188	169	306	293	136	128	904	882	412	353	1523	2.46	132	366	2562	2711	4.12	4.35	4441	4308	18700
23	139	135	427	339	183	169	328	297	127	129	922	885	407	357	1336	2.47	130	362	2451	2679	3.95	4.30	4404	4297	16800
24	145	136	418	342	186	170	325	300	127	129	869	881	411	359	1408	2.48	129	360	2336	2631	3.77	4.23	4516	4284	16480
25	148	137	444	346	187	169	326	302	130	129	933	880	415	360	1347	2.49	130	361	2437	2579	3.93	4.15	4478	4263	15360
26	148	138	449	348	197	170	322	305	133	130	810	870	413	361	1132	2.49	131	363	2395	2528	3.86	4.07	4553	4252	14464
27	151	139	382	354	188	172	336	308	133	131	711	851	392	363	986	2.49	136	373	2101	2468	3.41	3.97	4218	4241	14400
28	148	140	313	359	179	173	344	311	133	131	821	842	385	365	1053	2.50	145	388	2123	2414	3.44	3.89	3994	4228	14880
29	145	141	314	364	167	174	341	315	133	132	809	838	374	370	1132	2.54	149	397	2162	2393	3.50	3.86	4106	4241	14880
30	148	141	304	365	175	176	336	318	136	133	825	841	381	375	1294	2.58	160	416	2232	2381	3.61	3.84	4218	4271	16320
Mean	134		333		170		305		124		814		355		1152		136	373	2528		4		4225		15962

NOTES "TDS": Total Dissolved Solids, mg/l
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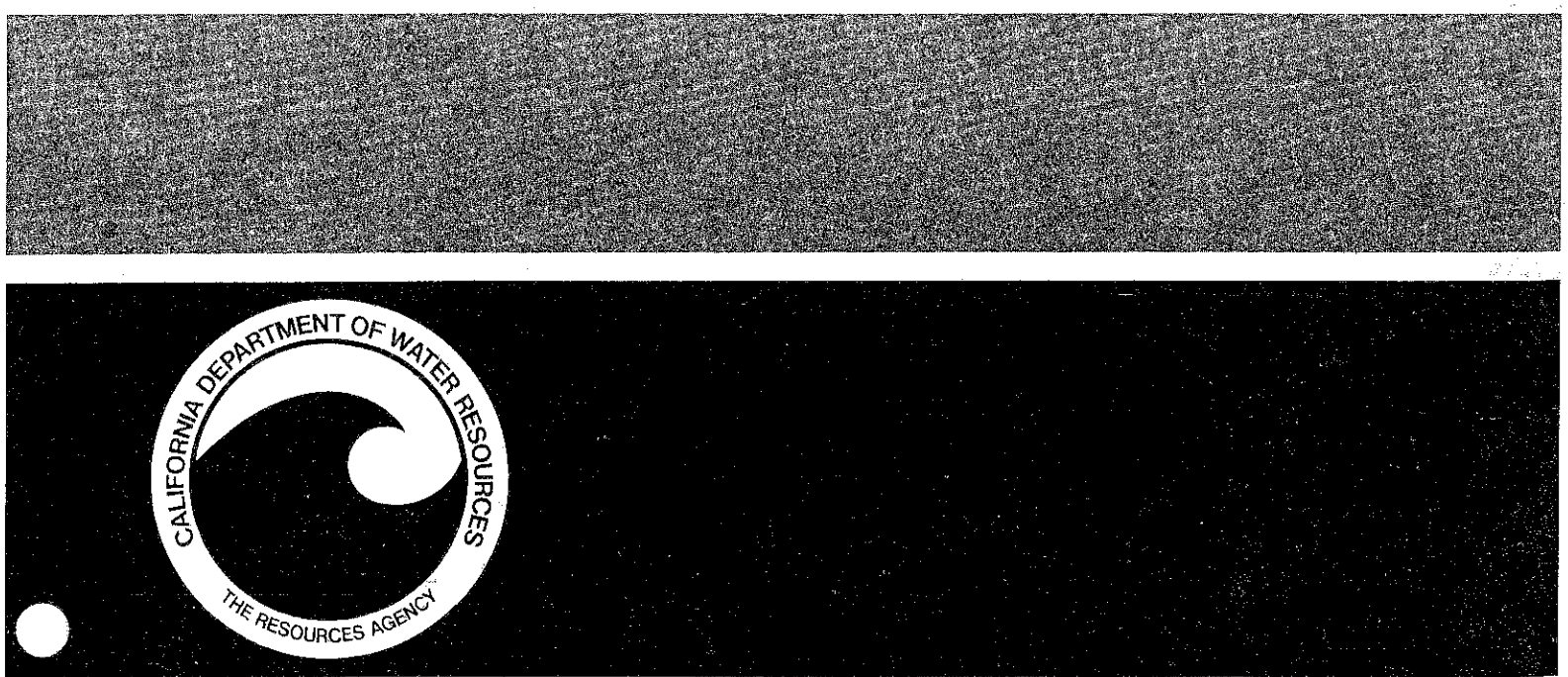
78947—950 3-79 1,500

Addendum 4
WATER QUALITY CONDITIONS AT SELECTED
DELTA LOCATIONS DURING 1976
-- December --

	Little Potato Slough @ Terminous		Sacramento River @ Rio Vista		San Joaquin River @ San Andreas Landing		Old River @ Clifton Court		Sacramento River @ Green's Landing		Sacramento River @ Emmaton		San Joaquin River @ Jersey Point		San Joaquin River @ Blind Point		Contra Costa Canal @ Rock Slough		San Joaquin River @ Antioch				Sacramento River @ Chipps Island		Suisun Bay @ Port Chicago
Day	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	TDS md	TDS 14 dm	Cl md	Cl 14 dm	Cl md	Cl 14 dm	Cl Daily Max.	EC 14 dm	Cl md	TDS md	TDS md	TDS 14 dm	EC md	EC 14 dm	Cl md	Cl 14 dm	TDS Daily Max.
1	142	142	359	372	187	179	358	323	133	133	861	850	417	384	1365	2.62	170	436	2385	2381	3.85	3.84	4329	4311	16480
2	136	142	360	378	197	183	346	326	127	133	997	865	415	391	1371	2.65	179	453	2419	2379	3.90	3.84	4516	4345	16320
3	130	142	439	387	224	186	343	329	124	132	1180	887	446	400	1527	2.70	181	456	2655	2386	4.26	3.85	4851	4393	17088
4	127	142	497	397	250	192	348	333	127	132	1324	918	471	408	1738	2.76	176	447	2869	2406	4.59	3.88	5112	4446	17600
5	127	141	548	407	255	197	364	337	127	131	1332	950	467	415	1636	2.82	178	451	2731	2419	4.38	3.90	5075	4486	17664
6	130	141	548	414	240	201	343	340	124	130	1245	974	733	438	1702	2.86	186	466	2785	2434	4.46	3.92	4963	4524	17312
7	127	140	566	424	241	205	364	343	124	129	1526	1017	708	459	1677	2.92	177	449	3036	2476	4.85	3.99	4908	4560	17440
8	118	138	629	439	247	210	365	345	124	129	1367	1053	729	482	1836	2.99	174	443	3648	2570	5.79	4.13	5097	4601	17920
9	118	136	598	450	295	217	363	348	127	129	1240	1075	704	503	1634	3.04	174	444	3731	2662	5.92	4.27	5077	4644	16960
10	127	134	426	449	202	218	395	353	115	128	1276	1108	626	518	1355	3.07	180	454	3446	2737	5.48	4.39	4602	4647	16160
11	115	131	428	452	199	218	401	358	118	127	1216	1144	612	533	1343	3.11	189	471	3389	2829	5.39	4.53	4484	4666	16160
12	115	129	439	461	200	220	395	362	124	126	1268	1176	615	550	1215	3.15	196	485	3471	2926	5.52	4.68	4493	4702	15616
13	112	127	454	471	207	223	378	364	118	125	1258	1208	615	567	1226	3.19	201	493	3487	3020	5.54	4.82	4481	4729	15680
14	115	124	445	481	214	225	391	368	121	124	1179	1233	598	583	1343	3.22	212	514	3299	3097	5.25	4.94	4425	4744	16160
15	115	122	439	487	221	228	396	371	118	123	1181	1256	605	596	1410	3.26	214	519	3259	3159	5.19	5.04	4446	4752	16320
16	118	121	474	495	229	230	408	375	118	122	1210	1272	611	610	1457	3.27	217	525	3342	3225	5.32	5.14	4485	4750	16960
17	112	120	602	507	260	233	439	382	118	122	1315	1281	700	628	1706	3.30	224	537	3733	3302	5.92	5.26	4903	4754	18240
18	115	119	690	520	285	235	431	388	115	121	1477	1292	739	647	1849	3.32	224	537	3923	3377	6.21	5.37	5129	4755	18176
19	118	118	691	531	281	237	454	394	118	120	1558	1308	725	666	1772	3.33	221	532	3851	3457	6.10	5.50	5014	4750	18112
20	115	117	695	541	264	239	475	404	112	119	1439	1322	684	662	1791	3.34	224	536	3747	3526	5.94	5.60	4871	4744	17792
21	118	117	676	549	270	241	495	413	115	119	1318	1307	672	660	1706	3.34	226	540	3668	3571	5.82	5.67	4860	4741	17472
22	118	117	620	548	232	240	485	422	115	118	1236	1298	633	653	1600	3.30	222	534	3529	3563	5.61	5.66	4807	4720	17440
23	118	117	609	549	245	236	491	431	115	117	1189	1294	623	647	1451	3.27	224	537	3491	3545	5.55	5.63	4040	4646	16640
24	118	116	562	559	239	239	437	434	118	117	1183	1288	629	647	1291	3.26	224	536	3483	3548	5.54	5.64	4665	4650	16160
25	118	116	437	559	208	240	434	436	115	117	1047	1276	565	644	1020	3.23	221	532	3024	3522	4.83	5.60	4247	4633	16320
26	118	116	399	557	205	240	435	439	115	117	998	1256	534	638	1045	3.20	225	538	2950	3485	4.72	5.54	4099	4605	14912
27	118	117	396	552	201	240	443	444	118	117	997	1238	556	634	1203	3.18	231	550	2996	3450	4.79	5.48	4143	4581	15360
28	118	117	383	548	195	238	435	447	115	116	979	1223	542	630	1289	3.16	233	553	2669	3405	4.28	5.42	4104	4558	15680
29	124	118	426	547	213	238	463	452	118	116	1035	1213	587	629	1396	3.16	237	561	3231	3403	5.15	5.41	4405	4555	16960
30	121	118	486	548	240	238	444	454	121	116	1221	1214	678	633	1749	3.19	234	555	3704	3429	5.88	5.45	4778	4576	18048
31	118	118	479	539	250	238	462	456	115	116	1183	1204	626	628	1576	3.17	233	553	3504	3412	5.57	5.43	4639	4557	17120
Mean	121		510		232		412		120		1220		609		1493		207	504	3273		5		4647		16847

NOTES "TDS": Total Dissolved Solids, mg/l
"Cl": Chloride, mg/l
"EC": Electrical Conductivity, milliSiemens
"md": Mean Daily; "14 dm": Mean of 14 Consecutive Days


CALIFORNIA DEPARTMENT OF WATER RESOURCES
THE RESOURCES AGENCY